AJYAL LIMITED COMPANY
Engineering Fiberglass Piping System,
Erection Maintenance Contractors and General Services

PRE QUALIFICATION AND TECHNICAL SUBMITTAL

Objective:

To work and comply on approved drawings, manufacturer procedure, standard and for the satisfaction of Client.

Goal:

To improve our knowledge's, skills and to give full support in our company and finished all work based on date of completion and or client recommendation.

OUR VISION:

To be a model in installation, design, supply and testing of Metallic and Non Metallic Piping System with total commitment to excellences.

OUR MISSION:

To provide a high standard of service to ensure prompt and quality results through the best utilization of our resources and technology.

Contents

I N T R O D U C T I O N

AJYAL LTD. CO. came into existence in 1998, with an aim to serve the Fiberglass Reinforced Plastic (FRP) piping industry. Since the company was established, it has been providing reliable services to FRP industry in the fields of erection, maintenance and testing.

Given the complexity, unpopularity of thermosetting resins and Fiberglass materials in application to the growing industries. Though they get the pipes and fittings readymade but when it comes to installation there are only few contractors who has mastered in terms with knowledge of fiberglass industry.

As the correct installation in accordance to proper engineering practice with proper field experience will indeed ensure the expected product design life.

AJYAL LTD CO. with its professional and experience work force developed from many years in the FRP field services has answer for your product to achieve long term performance, assurance to client's engineers and main contractors through proper product handling, installation, and maintenance.

With our origin firmly established in metallic and specialized in fiberglass piping industry, AJYAL LTD. CO. will continue to improve customer service with advanced state of art technology and knowledge to the best of customer satisfaction.

NATURE OF SERVICES

AJYAL Ltd. Co. offers services specializing in FRP piping system in accordance to specifications that is applicable local and international standards:

PRE PROJECT SERVICES

- Site study and review for FRP piping system installation.
- Installation procedure and method for FRP piping system.
- Preparation of installation plans and drawings.

ON - LINE PROJECT SERVICES

- Excavation, foundation, bedding backfilling, compacting for underground pipes.
- Installation and supervision of above ground and under ground piping system.
- Site connection of different types of pipeline joints both restrained and unrestrained.
- Quality control and safety management of FRP pipe installation.

POST COMMISSIONING MAINTENANCE SERVICES

- Surveillance Inspection and evaluation of existing condition of FRP piping system.
- Repair or replacement works for damaged FRP piping system or existing corroded steel or other metallic piping.
- FRP lining works for corroded or weakened FRP and non – FRP piping system such as concrete or steel.

Why Ajyal Ltd. Co.?

Rapid infrastructure development is going on around the world and also old infrastructure is aging. Millions of kilometers of new pipe lines is been laid and old pipe lines had been replaced by FRP pipes. As the Fiberglass pipes continues to take over from steel & concrete piping in an ever growing number of applications due to unique properties and characteristics as mentioned below.

- High strength to weight ratio
- Corrosion resistance
- Light weight
- Elimination of Coating & Painting
- Less Fluid Resistance
- Non-conductivity to electricity and heat
- Dimensional stability

To protect your investment in FRP piping system, proper installation should take place as it is the main aspect for the long term performance and reliability of the piping system. As the leading specialized company in FRP fabrication, installation, erection, and maintenance, AJYAL LTD. CO. will provide total solution for every fiberglass related works.

AJYAL LTD. CO. is enhancing its approach by bridging the gap between manufacturer and the end user by means of providing knowledge and experience through consultations and recommendations to attain customer satisfaction.

Pipe alignment: checking the elevation, if the pipe is completely resting on the gravel.

Pipe laying and joining: Using sling for lifting to secure the pipe in damage prior to joining and or installation.

Special cares during installation the pipe line will it takes longer.

The most important is to handle the pipe or fittings during upload and unload. Secure the pipe or fittings in drop, bending, and slide.

Let the pipe or fittings rest on the truck without nails, studs, and other objects might be damage them and secure in contact with metal by put padding

Sling should be fastened directly over the dunnage with tie downs consisting of nylon strap.

Ajyal ltd co. prepare the foundation shall be compacted and comply with the standard or approve by client.

Just to protect the life span and to achieve the condition of the pipe line.

Ajyal ltd co. will give the different techniques in installation and fabrication of pipes and fittings for the satisfaction of end user.

Ajyal ltd co. employee engineers and technician are all certified by doing installation of pipe and fabrication of fittings by the manufacturer. Technicians are well trained and giving different techniques for the satisfaction of client.

Conduct hydro static test on manifold prior to segmental hydro static test on the pipe line.

Using calibrated pressure gauges or pressure recorder for actual testing pressure in segmental test on the pipe lines.

Sewer line, Fuel line / Metallic or Non-Metallic pipe lines.

Conduct Hydro static test at joint of the pipe line, using hydraulic test machine. Technician well versed in the operation of manual pump and necessary testing appurtenances.

Ajyal ltd. Co. assures that the testing is done without leak at the joints.

TYPES OF FIBERGLASS CONNECTIONS

Below are various types of fiberglass connections in accordance to international standard requirements.

The general specification typically contains a classification system for the joints having two general categories.

A. **Restrained pipe joints** - can withstand internal pressure and longitudinal forces.
B. **Unrestrained pipe joints** - can withstand internal pressure but not longitudinal forces.

A. RESTRAINED PIPE JOINTS (RIGID JOINT)

A.1 BUTT AND WRAP JOINT (HAND LAY-UP JOINT)

Butt and Wrap joints well established and clearly specified in various international standards AWWA, ASTM, ANSI and ASME. It's highly reliable and widely used in various applications with underground and aboveground installation. Many experts consider butt and wrap joint on top of their choices, when it comes to long term performance and reliability for total tightness.

The butt and wrap joint typically consist of two squared or spigot which has been prepared for joining by roughening the outside surface in the joint area. These spigots are then butted end to end and align on the same center line and the joint over wrap with layers of resin impregnated glass fiber cloths. Each layer becomes increasingly wider to provide a build up that accommodates internal pressure and longitudinal forces. Basic joint construction appears in figure A-1

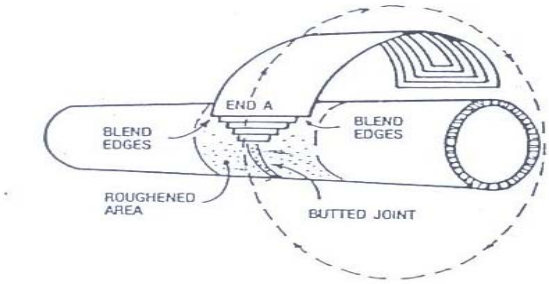


Figure A-1

Figure A-2 illustrates a variation in this joints in which the spigot OD's are tapered. Tapering reduces build up in diameter.

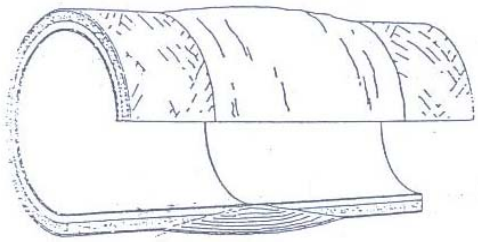


Figure A-2

A.2 - WRAPPED BELL AND SPIGOT JOINT

This is a variation of the butt joint as illustrated in figure A-3. In this system, the bell aids in alignment. The overlays can be sized to provide the strength necessary. Internal overlays are possible only on larger diameter pipes that allow the installer to work inside the pipe during installation.

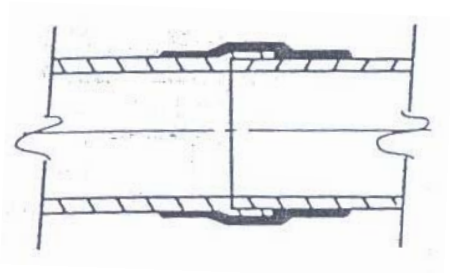


Figure A-3

A.3 - BONDED (ADHESIVE) BELL AND SPIGOT JOINT

This joint uses a bell and spigot without the sealing gasket, and an adhesive introduced at the interface during assembly. This is one of the commonly joining systems on small diameter piping systems. Figure A-4 illustrates the assembled joint.

Note: This joint is applicable only to RTR pipe.

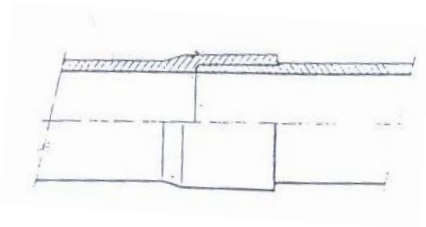


Figure A-4

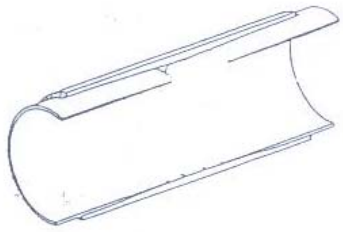


Figure A-5

Figure A-15 is a variation of this system using a coupling with internal taper at each end to mate with the tapered spigots.

A.4 - COUPLING OR BELL AND SPIGOT, JOINTS WITH RESTRAINING DEVICE OR KEY-LOCK.

Joints that use an elastomeric seal located in a groove on the spigot or in the bell (coupling) as soul means of the joint to provide fluid tightness, supplemented by the addition of a mechanical restraining device like a key. This is a non-destructively separable joining system.

Note: This joint is applicable only to RTR pipe.

Figure A-6 and A-7 schematically illustrates coupling type system with both gasket and a retaining element in the coupling and a groove to accept the retaining device in the spigot end of the pipe. Sealing is effected on the pipe OD, which maybe thicker than the pipe body, the shape and the material used for the restraining element can vary widely. Both metallic and shear resistant

plastic materials are used for this device. An advantage of this joint is that it can be disassembled for removal or repair.

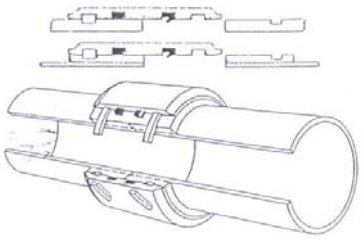


Figure A-6

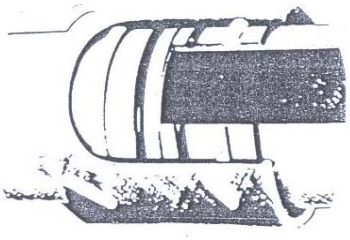


Figure A-7

Figures A-8 and A-9 illustrate bell and spigot ends with gasket and restraining elements. In figure A-9 the restraining element is a mechanically loaded locking ring design to expand and allow the spigot to enter the bell and then contract to lock on a shoulder on the spigot OD. The joint restraining element in figure A-10 is a thread

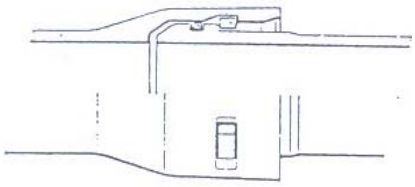


Figure A-8

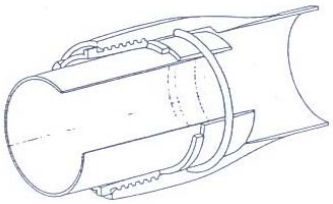


Figure A-9

A.5 - FLANGED JOINTS

Pressure rated flanges a common in the installation of all sizes of fiberglass pipe. Fiberglass flanges often mate with the ANSI/ASME pressure class of bolted flanges. In the fiberglass case flanges are produced by hand lay-up, filament winding and compression molding. Projects conditions often dictate mating a fiberglass flange with a pre-existing metallic flange on a pump, valve

or metallic pipe. Fiberglass flanges should be flat faced with a confined gasket. Raised faced flanges require an adapter to prevent over stressing. Bold circles are readily available in standard dimensions and can be made readily to fit special configurations. Figure A-10 depicts a fiberglass to fiberglass and fiberglass to steel flange using a flat faced gasket Figure A-11 schematically illustrates the flat faced flange with groove for a confined gasket which is often used in fiberglass piping systems.

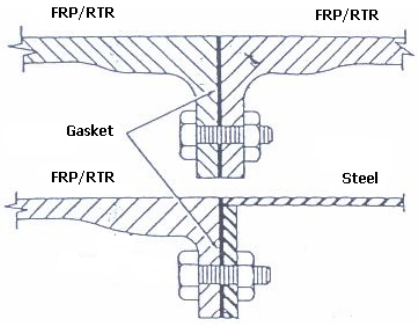


Figure A-10

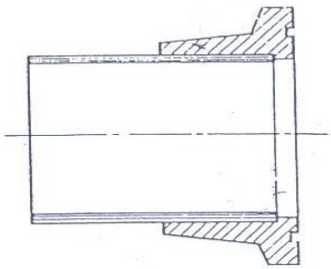


Figure A-11

A.6 - MECHANICAL JOINTS

A number of mechanical joint systems exist. Mechanical joint widely used on smaller pipe diameters is the threaded joint. These joints exist in both bell and spigot as shown in figure A-12 and coupling designs with a variety of threading patterns as shown in figure A-13.

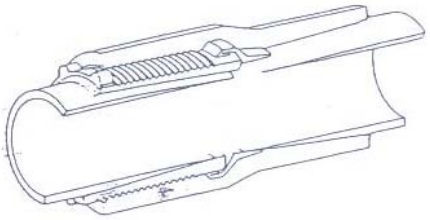


Figure A-12

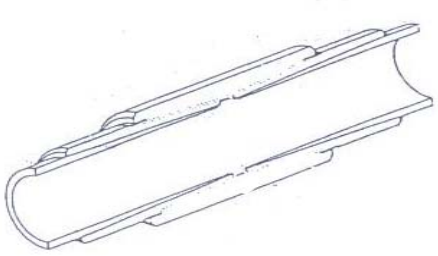


Figure A-13

B. UNRESTRAINED (FLEXIBLE) PIPE JOINTS

B.1 - COUPLING, OR BELL AND SPIGOT, GASKET JOINTS.

The coupling type joint

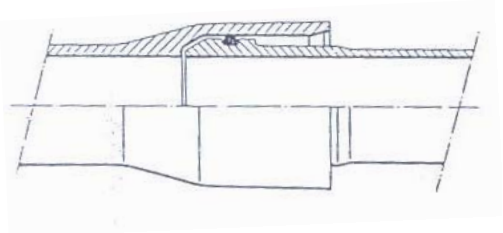


Figure B-1

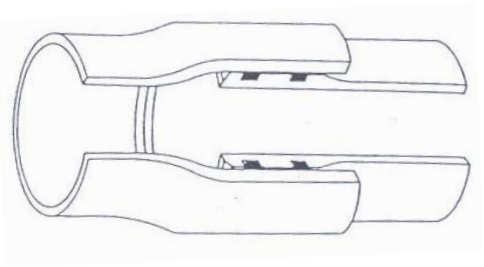


Figure B-2

Consist of length of tubular material with groove and gasket at each end. The coupling is sized such that the pipe slides into it compressing the seal and affecting a seal at each end. The bell and spigot design is similar except that the coupling (bell) is integral at one end of the pipe and the spigot is the other end. The pipe thickness might be increased in the joining area.

This joining system is not able to accommodate longitudinal forces. The above figures B-1 and B-2 illustrates bell and spigot system using both single and double gasket designs. The double gasket design applies only to larger diameter pipes. By inserting port through the bell and between the gaskets, one can test the joint immediately after assembly using pneumatic or hydrostatic techniques.

Figures B-3 and B-4 illustrates coupling joint assemblies. The joint in figure B-3 uses a gasket mechanically bonded, or molded, in the coupling. Figure B-4 shows a coupling with a multiple gaskets retained in grooves. Both seal against the pipe OD.

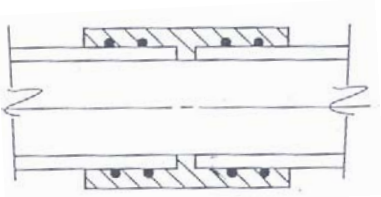


Figure B-3

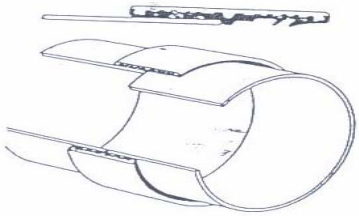


Figure B-4

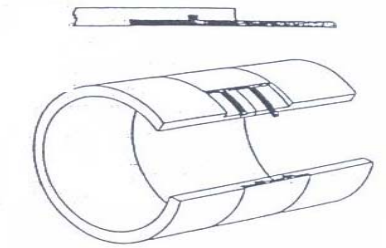


Figure B-5

Figure B-5 illustrates a flush joint configuration. That is joining system in which the pipe ID and OD are continuous smooth surfaces. This type of joining system is used in rehabilitation, slip lining and jacking projects.

B.2 - MECHANICAL COUPLING JOINT

Mechanically coupled joints typically seal on the OD of plain end pipes through the use of gaskets that are loaded mechanically (compressed) to have an effect on the seal. Figure B-6 shows a typical mechanically coupled joint. There is no ability to accommodate longitudinal forces in this design.

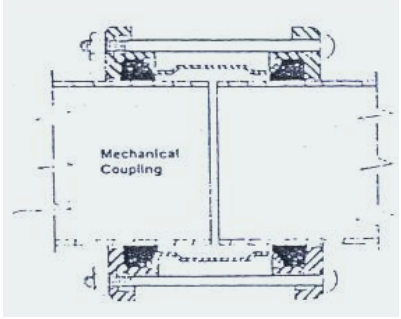


Figure B-6

INSTALLATION GUIDE LINES:

4.1 ABOVEGROUND INSTALLATION (A/G)

Proper installation of fiberglass piping system installed on, or above, the surface of the ground differs significantly form procedures to metallic systems.

A.) Two Categories:

a.1 - **Suspended or supported aboveground surface** in general, the objective of any above ground installation is to provide supports, guides and anchors points in such a way that the deflection of unsupported span lengths are maintained within acceptable limits over the long term.

a.2 - Directly on Surface

Install lines directly on the ground surface with care to avoid imposing excessive stresses, or strains on the system. Pay particular attention to the following:

Bending – take care that the pipe is not bent excessively as laid. Exceeding the minimum bend radius of the pipe results in undue stresses that might affect the long-term performance of the line.

Protection – Protect the pipe form mechanical damage from impact, vibration or pulsations from attached systems, point loading and abrasion from point loading.

B.) General Requirements:

Standard construction practices shall be used for installation of FRP piping aboveground. Adequate clearance to other piping and structures shall be mentioned to allow for thermal expansion and contraction.

FRP pipe shall be protected with saddle supports at all points of contact with the supporting structure.

General support type descriptions are as follows:

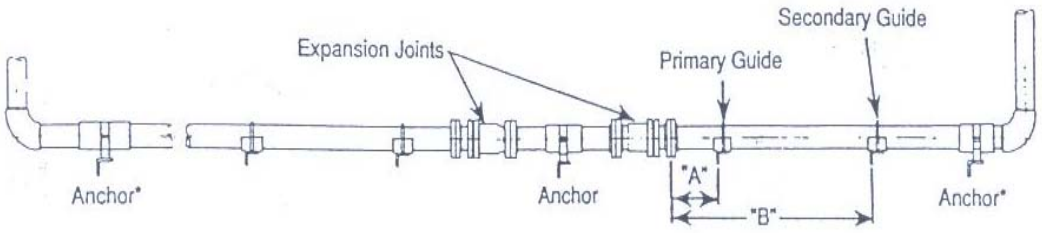
b.1 - **Anchors:** Support vertical loads and prevent lateral movement, axial movement and uplift rotation may be restrained to some extent, depending on the method of attachment to the supporting structure. Axial loads are transmitted to the support by use of shear collars attached to the pipe on each side of the anchor.

b.2 – **Simple sliding supports**: support vertical loads only and do not prevent lateral movement, uplift or rotation.

b.3 – Guides: support vertical loads and restrain lateral movement: vertical uplift is sometimes restrained. Axial movement is allowed and lateral movement is allowed to the extent of the gaps between the support base and the guide clips attached to the supporting structure.

b.4 – Other supports: several variations of the basic supports are often used in FRP piping systems, which most often utilize special configurations but accomplish the same basic function as the basic support types.

C.) Sample pipe Installation for Above Ground Installation



4.2) UNDERGROUND (BURIED) INSTALLATION (U/G)

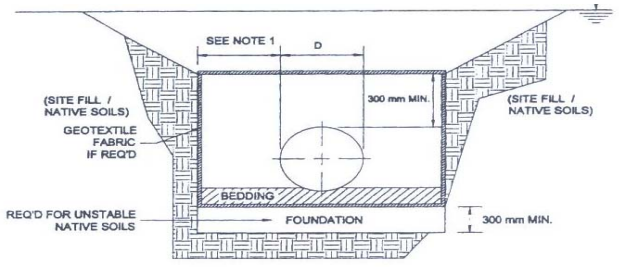
A.) General Requirements

Excavations shall be made to install pipe to the depths and alignments specified in the construction drawings and in accordance with the specification. Excess or unsuitable materials shall be removed to designated spoil areas or other wise dispose of in a manner satisfactory to the owner.

a.1 Trench Excavation

Trench shall be open cut with side slopes as shown on the construction drawings. The minimum width of the trench at any point below of the top of the pipe shall be sufficient to provide adequate space for bedding, joining, and backfill and compaction of the pipes. Refer to the following, Table and Figure.

Pipe Diameter (mm)	Side Clearance (mm)
100-300	200
350-800	300
900-1500	450
1600-2300	600
2400-300	800
3200-3700	900



NOTE 1: FOR SIDE CLEARANCE REQUIREMENTS REFER TO TABLE ABOVE.

Trench Construction
Figure 1

When the pipe is installed within an embankment, wide trenches, or in installations where the site is scarified and the pipe is installed within trenches or open cuts formed with general site fill material, the width of compacted backfill must be increased. The Pipe Zone backfill material must be compacted full width of the trench or two pipe diameters whichever is less.

Sheeting driven into or below the Pipe Zone that is likely to result in damage to the backfill from withdrawal should be considered permanent and left in place. Permanent sheeting should be cut off at least 500 mm above the top of the pipe and designated to last the life expectancy of the pipe.

Movable or temporary trench wall support should not be used below the top the pipe or within two pipe diameters from the sides of the pipe unless approved methods are used to maintain the integrity of the embedment materials. Voids left in the embedment materials should be filled with backfill material and adequately compacted.

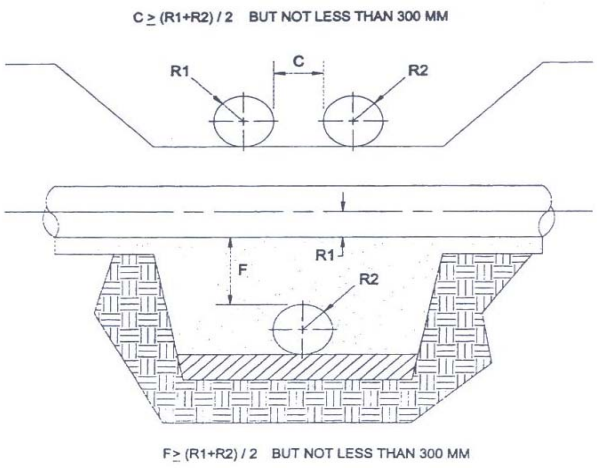
If pie installation depth and alignment result in less than minimum allowable clearance to foundations, footings, piping or other structures, approval and direction from owner is required.

The minimum clearance from foundations or other structures shall be 300 mm, measured in any direction from the pipe. If minimum clearance cannot be maintained the pipe shall be encased in concrete, cement stabilized sand, or cushioning materials placed in the vicinity of the interference. At the ends of any encasement the pipe shall be wrapped

with 12 mm thick Neoprene or other cushioning material as noted in the Design Submittal.

Special care is required for placement of material and to maintain compaction requirements of the specification where reduced clearance are encountered.

The minimum spacing between pipes at "cross-over" and for multiple pipes installed parallel in a common trench shall be determined as shown in Figure 2.



Spacing Between Pipe
Figure 2

a.2 Dewatering

No pipe placement or backfilling operation shall be done in the presence of free water. Proper drainage for excavated and adjacent areas shall be maintained to prevent the pounding of water. Excavated areas shall be kept dry by pumping other suitable methods.

Pumping long distances through backfill or native soils that could cause loss of support to existing services and structures through loss of materials or migration of fines shall be avoided.

Well point systems may be required where excavations extend below the groundwater levels. Well points (or a suitable dewatering method) should lower the groundwater level to at least 600 mm below the foundation substructure and over he entire width of the excavation.

Adequate lowering of the groundwater level in the excavation area shall be demonstrated through measurements in unplumbed well point or in observation wells. Dewatering shall be maintained as described above until 600 mm or one pipe diameter, whichever is greater, of constructed backfill above the pipe has been achieved, or as required by Contractor to prevent floatation or to complete final backfill. Do not turn off the dewatering system until sufficient cover depth has been reached to prevent pipe floatation.

Flooded Trench

When the ground water table is above the trench bottom, the water level must be lowered to at least the trench bottom (preferably about 200 mm below) prior to preparation of the pipe bed. If the water level cannot be maintained below the top of the bedding, special installation methods may be necessary to achieve proper pipe support. Consult the owner's engineer for specification of an appropriate procedure or approval of the method chosen.

Caution: If the pipe is empty in a flooded trench, a minimum cover of one pipe diameter of dense soil (1,900 Kg/m^3 or more) is normally sufficient to prevent pipe flotation. (See Burial Limitations – Minimum pg. 4-14)

a.3 Pipe Foundation

The trench bottom should be constructed to provide firm, stable and uniform support for the full length of the pipe. The trench bottom is considered the top of the pipe foundation when in-situ soils are stable and uniform. The pipe bedding material is placed on top of any

foundation. Fragments or rocks larger than 19 mm in any dimension shall be removed from the pipe installation area within the trench. When rock, hardpan or other hard inclusions encountered in the trench bottom, it should be removed and the over-excavation filled with a granular material compacted to provide a suitable foundation. A cushion should be constructed over any remaining hard inclusions with bedding material and be at least 300 mm thick. If there is a sudden transition from rock to softer material the possibility of differential settlement must be considered and accommodated by the cushion. The pipe Designer shall be consulted to provide the requirement for construction of a suitable foundation construction and cushion. When an unstable trench bottom, typically soft, loose or shows a "quick" tendency, additional depth should be excavated and a foundation must be constructed to provide firm, stable and uniform support for the pipe and to minimize differential settlement. In these situations special foundations may be required. The foundation materials must be selected to avoid migration or the use of geotextile fabric shall be considered to prevent the loss of pipe bottom support. The pipe Designer shall be consulted to provide the requirements for construction of a suitable foundation.

Only Class I material shall be sued for construction of the pipe foundation.

a.4 Bedding

- Class 1 material shall be placed to provide uniform Bedding and continuous support of the pipe at every point along its length.
- Bedding shall be constructed upon the stable Pipe Foundation bedding thickness shall be a minimum of 150mm.

- Bedding material shall be placed in 150 mm maximum uniform loose lifts and compacted water flooding of Bedding is not permitted. Soils shall be moistened or dried as required to achieve the specified degree of compaction density.
- The Bedding material shall be shaped to fit the outside diameter of the pie to ensure complete, continuous support of the pipe. Soil shall be shaped to a minimum height of 5% of the outside pipe diameter
- As an alternative to shaping the Bedding material, the compacted bed may be slightly loosened at the invert to a maximum of 25 mm deep to seat the pipe and additional Bedding material worked under the pipe by hand to a minimum height of 5% of the outside diameter. Compaction shall be by hand tamping.

Bedding Pipe

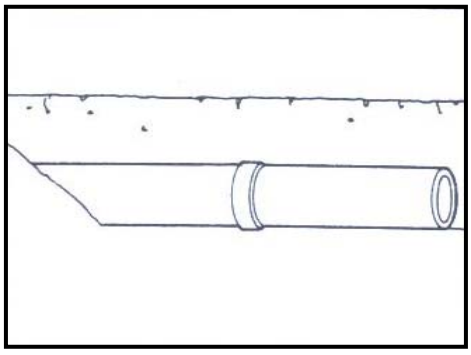
Pipe bedding material shall be sand or gravel per the requirements of the section on backfill materials (pages 4-14 and 4-15) and be the same as that utilized for select material in the remainder of the pipe zone. The bedding shall be compacted to a minimum 90% Standard proctor Density (70% of maximum relative density for crushed rock, crushed stone, and gravels). The finished bed should be plane, and must provide uniform and continuous support for the pipe (Figures). Prior to pie placement, slightly loosen the compacted bet at the invert location to go a depth 25 to 50mm so the pipe, when positioned into the trench, will seat well into the bed. Over excavate the bed at each coupling (joint) location to insure that the pipe will have continuous support. The pipe should not rest on the coupling for support. However, assure the coupling area is properly bedded and backfilled after the joint assembly is completed.

Backfilling Pipe

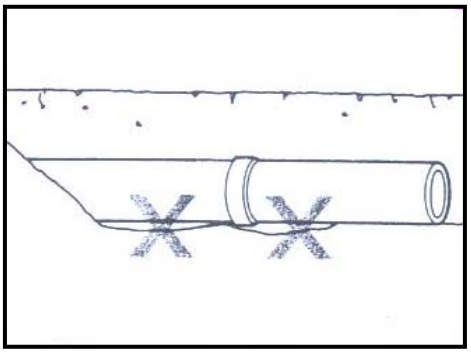
On most construction sites, it will be desirable to keep excavation, pipe installation, and backfilling close together to minimize logistics problems and to reduce supervision costs. Immediate backfilling after joining will prevent two serious hazards floating of pipe and thermal movement. Flati9ng of pipe can damage the pipe and create unnecessary reinstallation costs. Thermal movement caused by exposure to the elements can cause the loss of joint seal due to movement of several lengths acting on one joint. FIBERGLASS Pipe ordinarily can be laid and assembled as rapidly as the contractor opens the trench.

Proper selection, placement and compaction of pipe zone backfill is important to controlling the vertical deflection and is critical to the pipe performance. Adequately installed pipes will have initial deflection less than the values in Table 4-1 on page 4-1 and no bulges, flat areas, or other abrupt changes of curvature. It must be understood that judgment of installation quality (acceptability) by measurement of initial deflection is valid only when the specified installation procedures have been followed, enabling long-term effects to be reliably predicted. Maximum long-term pipe deflection is 5%.

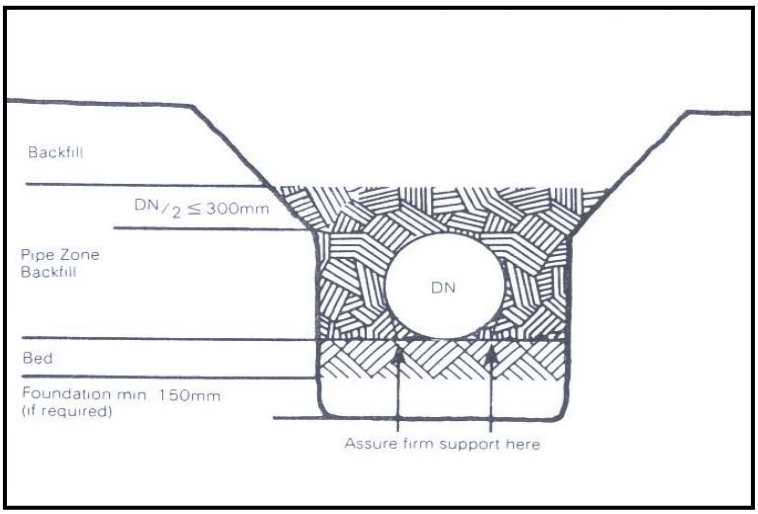
Note: Refer to Appendix G for estimated bed and pipe zone select backfill volume requirements.



Proper Bedding Support



Improper Bedding Support

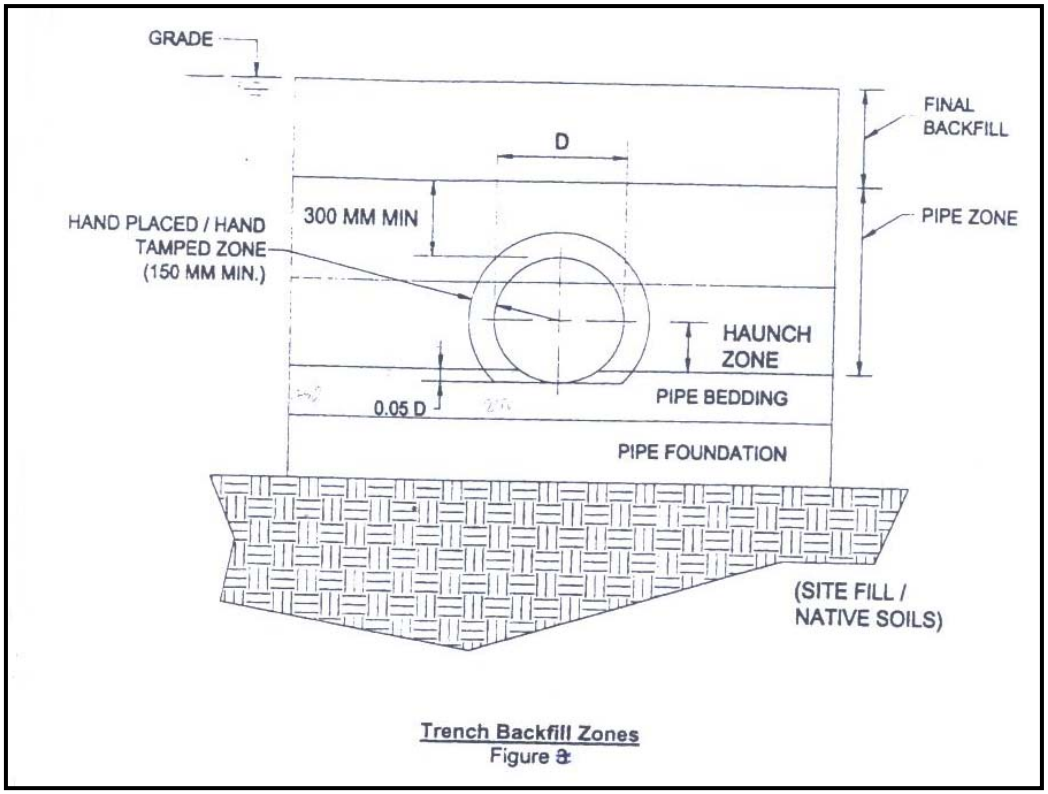


Pipe Backfilling

a.5 Backfill

- The Pipe Zone shall extend from top of the Bedding up to a minimum of 300 mm above the pipe as shown in figure. Backfill of pipe hall include the entire Pipe Zone as shown on Figure.
- Material placed in the Pipe Zone shall be Class 1 and placed alternately along both sides of the pipe in maximum 150mm loose lifts and compacted. Soils shall be moistened or dried as required, to achieve the specified degree of compaction density.

Take special precautions near bell-and-spigot gasketed joints so as to not cause a significant difference the amount of deflection of the spigot versus the bell ends of the pipe. A large difference in hoop deflection from one side of the joint to the other side may prevent the gaskets form sealing. This is especially important in larger diameter pipe which are more flexible.



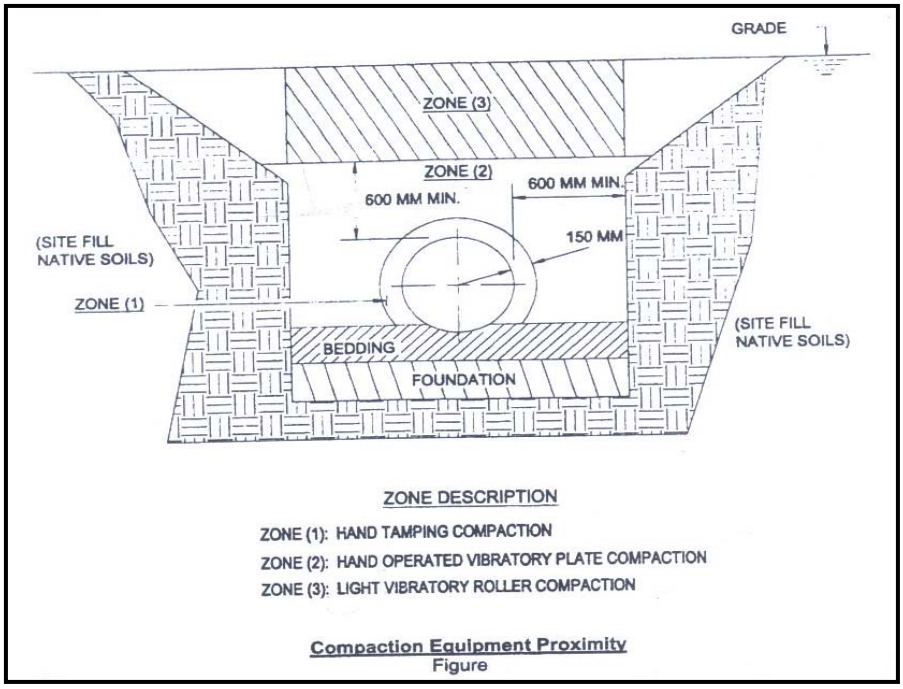
Trench Backfill Zones
Figure 8

- Within the Pipe Zone the Haunch Zone extends from the pipe invert to the spring line of the pipe.
- Within the Haunch Zone, Contractor shall ensure through placement and compaction of material.
- Soil in the Hand-Placed Zone shown in Figure shall be placed and compacted.
- The Hand-Placed Zone shall extend 150 mm radically from the pipe wall.

Final Backfill shall extend from the top of the Pipe Zone to the final grade as shown in Figure. Material placed in the Final Backfill shall be Class I or Class II material or common site backfill. Material shall be placed in 150 mm to 230 mm loose lifts and compacted according to general sit procedures by the Contractor.

Soils shall be moistened or dried as required, to achieve the specified degree of compaction density.

Compaction in the vicinity of the pipe shall be accomplished in accordance with Figure.



Compaction Equipment Proximity
Figure

Hand-tamping is the only method of compaction allowed within a 150 mm envelope surrounding the pipe circumference. Soil shall be shoveled into place and thoroughly hand tamped with a tamper of suitable configuration that will not damage or displace pipe.

Hand-operated vibratory-plate compactors shall not be allowed closer than 150 mm from the pipe laterally or vertically. The maximum weight of compaction equipment shall be that shown in the following Table or the manufacturers maximum recommended loading whichever is less.

Maximum Weight of Compaction Equipment within Zone 2

MINIMUM PIPE COVER (mm)	MAXIMUM WEIGHT OF COMPACTION EQUIPMENT (kg)
150	< 100
250	100
350	200
450	500
600	1000

Light vibratory-roller compactors shall not be allowed closer than 600 mm, measured in any direction form the side of the pipe. When operated directly above the pipe the dynamic force at the surface shall not exceed the equivalent weight of the compaction equipment in the following Table or the manufacturer's maximum recommended loading whichever is less.

Maximum Weight of Compaction Equipment within Zone 3

MINIMUM PIPE COVER (MM)	MAXIMUM WEIGHT OF COMPACTION EQUIPMENT
600	1000
900	2000
1200	400
1500	8000
1800	12000
2200	18000

Care shall be taken to avoid vertical or lateral displacement of the pipeline from soil placement or compaction. In the event this occurs, the affected length of pipe shall be excavated tot eh top of the Bedding layer and reinstalled per this Specification.

Table 4-6 Acceptable Pipe Zone Backfill

- **Gradation**

Specification	Acceptable[6]	Maybe[6, 7] Acceptable
Gravel	GW,GP GW-GC,GW-GM GP-GC, GP-GM	
Clean Sand	SW, SP SW-SC, SW-SM SP-SC, SP-SM	
Sand	SW, SP SW-SC, SW-SM SP-SC, SP-SM	SM, SC GM, GC

- **Maximum Grain Size**

Maximum Gravel Pipe Diameter	or Stone Size
Less Than 600 mm	13 mm
600 mm to 1600 mm	19 mm
Greater than 1800 mm	25 mm

Backfill Materials Compatibility

It is very important that the pipe zone backfill material not was-way or migrates into the native soil Likewise; potential migration of the native soil into the pipe zone backfill must also be prevented. Should this happen, the pipe may lose its side support, deflect excessively, and not perform as intended. Typically, migration can only occur if there is movement of water in the pipe zone and the following relationship exists between the two adjacent soils: Where incompatible materials must be used, they must be separated by filter cloth designed to last the life of the pipeline to prevent was-away and migration.

Where native soil is shown in the pipe zone, the following restrictions apply:

1.) No rocks greater than maximum gravel size.

2.) No soil clumps greater than 2 times the maximum gravel size.

3.) No frozen material.

4.) No organic material.

5.) No debris (tire, bottles, metals, etc.)

6.) Where compaction is specified: the native soil must be granular in nature (classification).

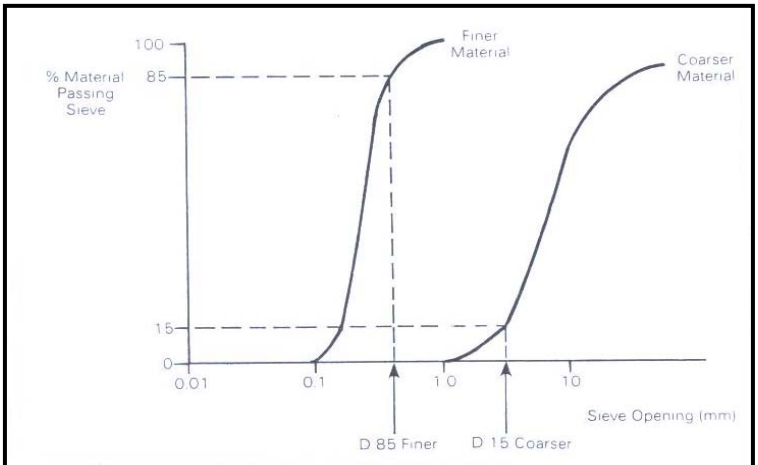


Figure 4-20 Backfill Migration Criteria

Pipe Zone Backfill

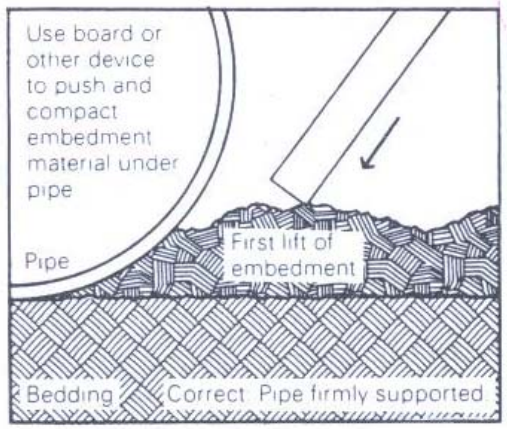
Pipe Zone Backfill (see Fig.) must meet the requirements given in the section on Backfill materials. Be sure that the backfill material is not frozen and is not contaminated with debris or other foreign materials that could damage the pipe or cause loss of side support. D not dumps backfill onto the pipe from the top of the trench. During backfilling, make certain that the granular material flows completely under the pipe to provide full support. A board or other blunt tool may be used to push and compact the backfill under the pipe. Proper completion of this step is a very important phase of backfilling the pipe. Proper backfilling should be done in

150 mm to 300 mm lifts, depending on backfill material and compaction method. Between each lift, be sure the proper compaction is attained to ensure that the pipe will have adequate side support. Note that compaction of sandy (vs. gravel) backfills is accomplished most easily when the material is at or near its optimum moisture content. When backfilling reaches pipe spring line (half of diameter), all compaction should be done first near the trench sides and proceed toward the center. Placing and compacting of the pipe zone backfill may cause the pipe to deflect (ovalize) in the vertical direction. Initial vertical ovalization must not exceed 3% of diameter. This measurement is determined when backfilling reaches pipe crown. All lifts with a specified density must be properly compacted. Consult Table below to determine the maximum weight of compaction equipment that may be used directly above the pipe. Care must be taken to avoid excessive compactive effort above the pipe crown, which may cause bulges or flat areas; however, the material in this area must not be left loose, if a specific density is required.

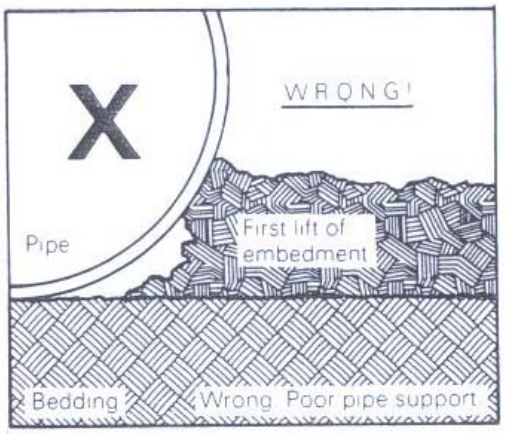
Table 4-7 Minimum Cover for Compaction above Pipe[1]

	Minimum Pipe Cover[1] (mm)	
Equipment Weight (Kg)	**Tamped**	**Vibrated**
Less Than 100	250	150
100 to 200	350	200
200 to 500	450	300
500 to 1000	700	450
1000 to 2000	900	600
2000 to 4000	1200	800
4000 to 8000	1500	1000
8000 to 12000	1800	1200
12000 to 18000	2200	1500

It may be necessary to begin with higher cover so that as compaction is achieved, the cover will not be less than the minimum.



Ensuring firm pipe support

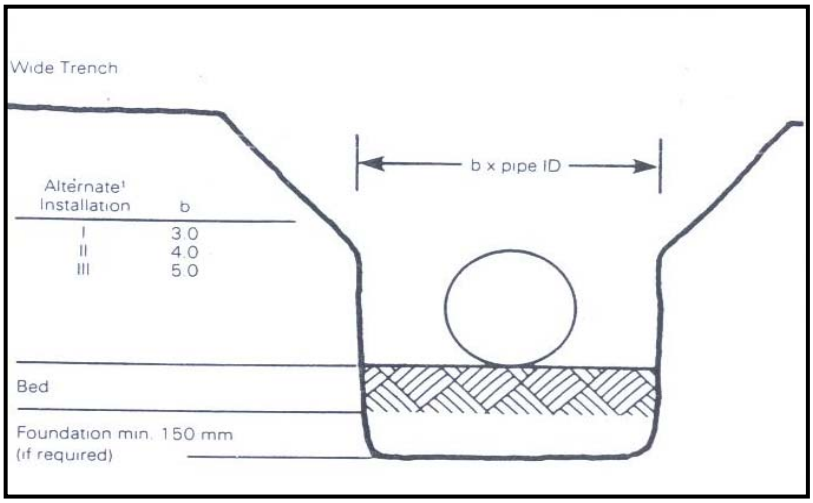


Improper Haunch

Alternate Installations

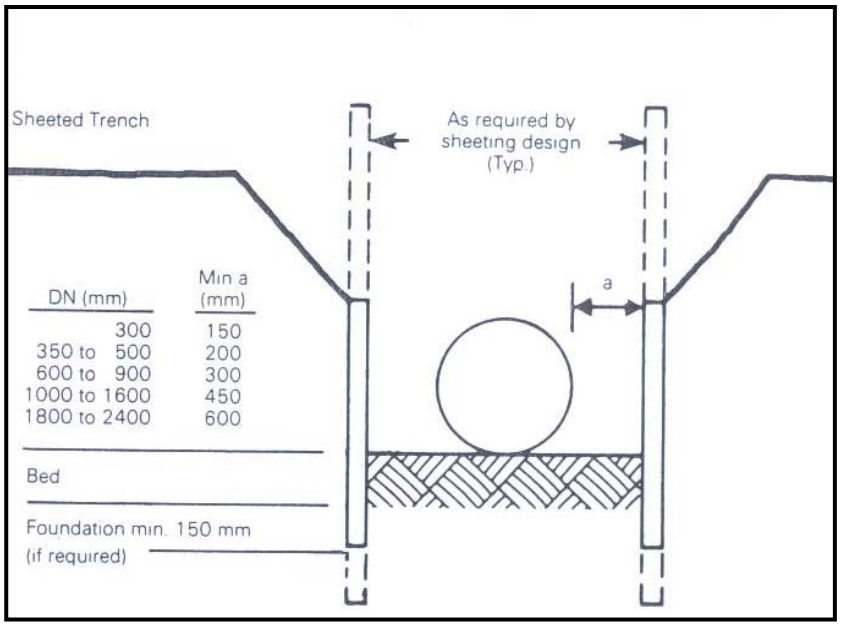
When the combination of pipe stiffness, cover, depth, and native soil characteristics places the installation required in the alternate category, several options are available as follows:

1. Use a higher stiffness pipe to permit a standard installation.
2. Increase the trench width per Figure below



Wide Trench

3. Use permanent sheeting of sufficient length to appropriately distribute the pipe lateral loads and of sufficient quality to last the design life of the pipe (50 years). See Figure below.



Permanent Sheeted Trench

4. Use cement stabilized backfill inn the pipe zone to support the pipe. Typically, 40 to 50 Kg of cement per ton of sand may be sufficient, although this will depend on the specific characteristics of the native soil, the trench width, pipe stiffness and backfill materials consistency. Consult the owner's engineer for specification of an appropriate procedure or approval of the method chosen.

a.6 Bedding and Backfill Material

- Class 1 material shall be placed to provide uniform Bedding and continuous support of the pipe at every point along its length.
- Bedding shall be constructed upon the stable Pipe Foundation bedding thickness shall be a minimum of 150mm.
- Bedding material shall be placed in 150 mm maximum uniform loose lifts and compacted water flooding of Bedding is not permitted. Soils shall be moistened or dried as required to achieve the specified degree of compaction density.
- The Bedding material shall be shaped to fit the outside diameter of the pie to ensure complete, continuous support of the pipe. Soil shall be shaped to a minimum height of 5% of the outside pipe diameter
- As an alternative to shaping the Bedding material, the compacted bed may be slightly loosened at the invert to a maximum of 25 mm deep to seat the pipe and additional Bedding material worked under the pipe by hand to a minimum height of 5% of the outside diameter. Compaction shall be by hand tamping.

Material Classification

Backfill material shall conform to the following classification system. Symbols for soil types are in accordance with the Unified Soil Classification System per ASTM D2487. Percentages sated herein are by weight. Maximum particle size in all backfill and bedding material shall be19mm.

Class I

- Soil type shall be crushed rock, clean gravel GW or GP, or clean sand SW, or SP
- Gradation of soil shall be as follows:
    - Crushed rock shall be gradation # 67 in accordance with ASTM D448.
    - **Gravel** – 50% or more of course fraction retained on a # 4 sieve, and
        - with less than 5% passing a #200 sieve.
    - **Sand** – 50% or more passing a #4 sieve, and less than 5% passing a
        - #200 sieve.
- Compaction methods, as determined by Contractor, shall achieve the equivalent of greater than 70% relative density per ASTM D4253 and D4254 or greater than 95% of the maximum dry density per ASTM D698.
- Density shall not exceed 2400 kg/m^3

Class II

- Soil type shall be san with silt, SW-SM or SP-SM
- Gradation of soil shall be as follows:
- Sand – 50% or more passing a #4 sieve, and less than 12% passing a # 200 sieve.
- Compaction methods, as determined by Contractor, shall achieve the equivalent of greater than 70% relative density per ASTM D4253 and D4254 or greater than 95% of the maximum dry density per ASTM D698.
- Density shall not exceed 2400 kg/m^3

Cement Stabilized Sand

Cement stabilized sand may be used as an alternate backfill material or locally in areas requiring greater support. When cement stabilized sand is used the mix ratio shall be one sack of cement (41 kg) per ton of sand or $1^{1/2}$ sacks of cement per 0.75 cubic meter of mix.

Use of Geotextile Fabric

If native soils are finer than the open-graded backfill material and if groundwater flow or fluctuations of the water table are expected within the Pipe Zone, a geotextile fabric such as Mirafi 1660NS or approved equivalent shall be used. Geotextile shall be placed at the interface between all Pipe Zone bedding and backfill and the native soils or general site fill, and shall extend over the top of the Pipe Zone bedding and backfill, and the native soils or general site fill, and shall extend over the top of the Pipe Zone. Refer to Figure 1.

Construction Traffic Loads

Under no circumstances shall traffic be allowed over the pipe with less than 600 mm of property compacted backfill covering the pipe.

Once the pipe is covered by a minimum of 600 mm of compacted backfill, surface loads given in the following Table or the manufacturers maximum recommended loading whichever is less are allowed over the pipe without protective matting.

Allowable Temporary Construction Traffic Loading

MINIMUM PIPE COVER	STANDARD TRUCK AXLE LOAD (kg)	TRACKED VEHICLE DISTRIBUTED LOAD (kg/m2)
600	6800	3000
1200	20000	8000
1800	40000	16000
2400	50000	21000
3000	60000	26000

Assumes a minimum track loading area of 2.5m^2 and loading area length to width ratio no greater than 1:4

Under circumstances shall heavy loads imposed by hauling equipment, heavy compaction, equipment cranes, pile driving, or other construction equipment be allowed directly over, or within 3 pipe diameters or 2.0 m (whichever is greater) from the sides of the pipe without implementation of some measure designed by the Contractor to protect eh pipe. Matting shall be designed by the Contractor such that the allowable pressures specified by the pipe manufacturer are not exceeded. Matting design shall be submitted to the owner for approval. Alternatively, haul roads or pie sleeves may be designed by the Contractor to protect the pipe and supporting soil envelope.

Pipe Buoyancy

When groundwater elevations indicate the potential for flotation, dewatering shall be maintained until 600 mm or one pipe diameter, whichever is greater, of constructed backfill above the pipe has been achieved or until sufficient cover is in place to prevent flotation. To determine the sufficient depth of cover only the weight of the pipe and overburden shall be considered. In situations where pipe flotation cannot be prevented by overburden alone, design of an anchoring system is required by the pipe manufacturer.

Concrete Encasement

Where concrete protection of the pipe is required, the pipe shall be encased in a minimum 300 mm thick layer of concrete. A 300 mm thick layer of concrete shall be laid at the bottom of trench extending at lest 600 mm wider on each side of the pipe. The concrete encasement shall extend a minimum of 300 mm above the pipe. Pipe saddles shall be placed on the bottom slab such that the pipe laid conforms to the elevations, gradients and alignments required on the drawings. A 12 mm to 25 mm resilient material shall be placed between the supports and the pipe.

The concrete shall be poured in lifts or other measures shall be employed to prevent the pipe form lifting or floating and to prevent excessive pipe deformation or collapse.

Where the pipe projects beyond the ends of the encasement, the pipe shall be wrapped in rubber to mitigate stresses and provide flexibility at the FRP concrete interface. The manufacturer's procedure for wrapping the pie shall be followed.

To minimize the potential effects of settlement of the encasement after installation of the pipeline, one of the following procedures shall be taken. The requirements for either method shall be provided by the pipe Manufacturer.

a. **Unrestrained Joints** – When bell and spigot or coupling joints are used, a short section of pipe shall be installed adjacent to the pipe section cast into the concrete. The length of this pipe shall be the smaller of one meter or one pipe diameter as a minimum and the smaller of two meters or two pipe diameters as a maximum. Allowable angular displacement of the joint design shall be checked to assure that articulation of this section will be adequate to resolve the settlement.

b. Restrained Joints – When laminated or adhesive joints are used or for continuous runs of pipe partially encased, pipe near structures shall be under laid with a low stiffness material

The Contractor shall prepare a procedure describing the method for concrete encasement, the method to prevent pipe uplift, and the method used to accommodate settlement for approval by the owner.

Connections and Appurtenant Structures

Thrust Blocks

Where the Design Submittal calls for thrust blocks, they shall be installed to the dimensions specified. The concrete shall be reinforced as necessary to fully transmit the thrust force to the bearing soils. The following minimum requirements apply to thrust block installation.

a. Completely surround the pipe for the entire length of the fitting, or a length of at least 300 mm or one half the diameter, whichever is larger.
b. At the ends of the encasement, the pipe shall be wrapped with rubber to cushion the pipe and distribute stresses.
c. Thrust blocks shall be shaped with the bearing area against undisturbed native soil or backfilled with pipe zone material
d. The concrete mix and reinforcing shall be in accordance with relevant Royal Commission specifications and shall exhibit a minimum strength as required in the Design Submittal
e. Thrust blocks may not be backfilled until the concrete has cured sufficiently to prevent contamination by the backfill material
f. The pipe shall not be tested or 0placed in service until the concrete has fully cured.

Protective casings

Install guides and support on pipe to be inserted inside of casings or pipe sleeves as required by the Design Submittal.

If guides or support are not otherwise required, the pipe shall be protected from sliding damage using spacers or skids attached to the pipe. Consult the pipe manufacturer for typical configuration.

Requirements for protective casings are as follows:

a. The annular space between the pipe and the casing shall not be filled.

b. The ends of the casing shall be closed with a flexible seal to prevent infiltration of water and soil and to accommodate vertical settlement.

c. Both ends of the casing shall be vented in a manner which does not allow entrance of water, soil or pests.

Valve boxes and Manholes

Concrete manholes and valve boxes shall be installed so that they do not bear directly on the pipe and create localized concentrated loading. Installation of these structures shall be as detailed on the drawings. Where the pipe passes through the structure the knockout shall be oversized to accommodate 150% of the anticipated settlement and the pipe shall be fitted with short pipe and flexible joints or cushioned. The Knockout shall e sealed and water tight. Flanged connections at valves shall include spacers to ensure proper fit-up, installation, and servicing of the valve.

Connection to Structures

At all connections or penetrations of appurtenant structures, provisions shall be made to accommodate differential settlement relative to the pipe. Specific instructions and details for joining and cushioning of pipe shall be provided by the

pipe manufacturer, where possible , pre-load structures for a suitable settlement period prior to joining adjacent pipe such that settlements are minimized after joining the pipe.

Survey concrete structures to confirm that further settlement after joining pipe will be negligible. This shall be accomplished by surveying at regular intervals until no measurable difference is recorded.

Burial Limitations

The following circumstances require minimum cover depths (in meters) as indicated:

Installation[2]	Allowable Negative Pressure (kPa)			
	SN[3] 1250	SN[3] 2500	SN[3] 5000	SN[3] 10000
1	-50 -75 to 5m -100 to 3m	-100	-100	-100
2	-25 -50 to 4m	-75 -100 to 6m	-100	-100
3	NR[4]	-25 -50 to 4m	-75 -100 to 6m	-100
4	-	-25	-50 -75 to 4m	-100
5[5]	-	-	-	-100[5]

Traffic

All pipe zone and backfill to grade must be compacted when traffic loads are to be present (see Table 4-4)

Table 4-4 Traffic Load Minimum Cover Depths

Load	Minimum Cover (m)
AASHO[1] H20	1.0
BS 153 HA	1.5
COOPER E80 RR	3.0

Note: Minimum cover restrictions may be reduced with special installations such as concrete encasement, concrete cover slabs, casings, etc.

High Water Table

A minimum of one pipe diameter of earth cover (minimum dry soil bulk density of 1900 Kg/m^3) is required to prevent an empty submerged pipe from floating. Alternatively, the installation may proceed by anchoring the pipes. If anchoring is proposed, restraining straps must be a flat material minimum 25mm wide placed at maximum 4 meter intervals.

Negative Pressure

For pipes that may have an operating negative pressure, assure the installation used and the minimum cover depth satisfy the requirements in Table 4-5.

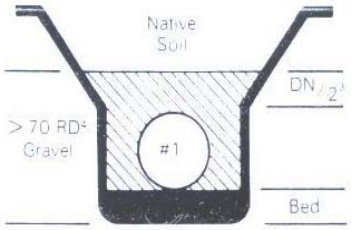
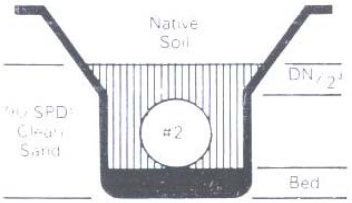
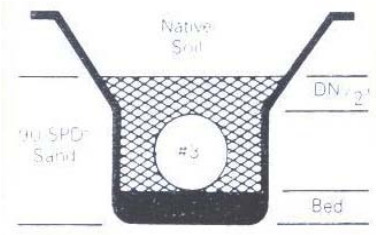
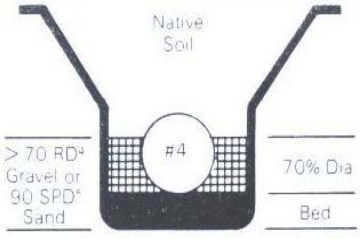
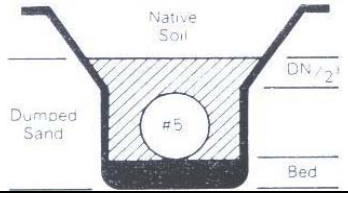
Burial Limitations – Maximum

Because FIBERGLASS pipes are flexible conduits, they must be supported by the surrounding soil to carry the overburden loads. The allowable cover depths are related to the type of pipe zone backfill material and its compaction (density), native soil characteristics, trench construction, and pipe stiffness. Table 4-3 and Figs. 4-3 to 4-18 give maximum cover depths for standards installations for various stiffness pipes.

Where alternate installations are used, the same cover depth limitations are suggested provided trench construction has been modified per the alternate installations section detailed on page 4-18. the values given in Table 4-3 and Figs. 4-3-4-18 are intended as guidelines to aid the installer in selection a backfill material compaction-pipe stiffness combination to achieve the required installation for the pipe. Whatever installation is selected the initial pipe deflection must not exceed the values in Table 4-01 on page 401.

If pipe deflections exceed the above stated limit, the installation must be improved. It must be understood that judgment of installation quality (acceptability) by measurement of initial deflection is valid only when the specified installation procedures have been followed, enabling long-term effects to be reliably predicted. Maximum long-term pipe deflection is 5%.

Table 4-5

Pipe Installation / SN[1]	1250	2500	5000	10000
	7	8	12	16
	6	7	10	14
	4	5	8	12
	NR[2]	3	6	10
	NR[2]	NR[2]	NR[2]	3

Thrust Restraints

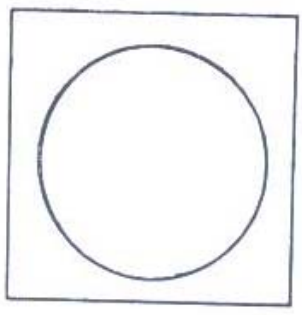
When the pipeline is pressurized, unbalanced thrust forces occur at bends, reducers, tees, wyes, bulk heads and other changes in the line direction. These forces must be restrained in some manner to prevent joint separation. When the surrounding soil cannot provide this restraint, thrust or stress/thrust blocks must be used. Determination of need and design of these restraints is the responsibility of the owner's engineer subject to the following limitations:

Thrust Blocks

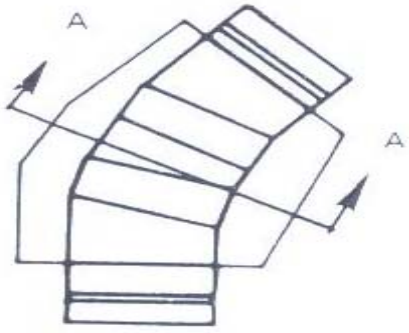
Thrust blocks must limit the displacement of the fitting to 0.5% of the diameter or 6mm whichever is less. The block must completely surround the fitting for its entire length and circumference (Figure 6-1) and should be placed either against undisturbed earth or backfilled with pipe zone materials as appropriate for the native soil characteristics, See sections on Rigid Connections and Concrete Encasement for details of pipe installation and system layout.

These Block are applicable to:

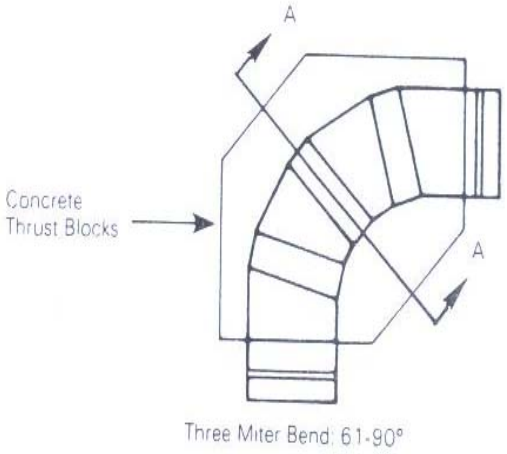
1. All bends, reducers, bulkheads and blind flanges.
2. Tees, when the branch pipe is concentric to the header pipe centerline.



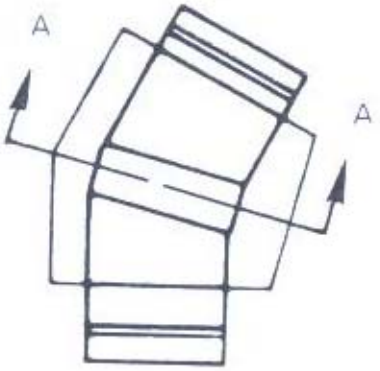
Section A-A



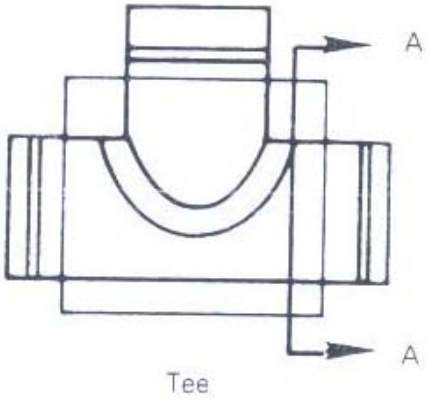
Two Miter Bend: 31-60°



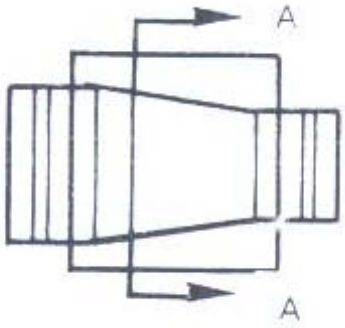
Three Miter Bend: 61-90°



One Miter Bend 0 30°



Tee



Reducer

Thrust / stress Blocks

Thrust/Stress blocks must limit the displacement of the fitting to 0.5% of the diameter or 6mm whichever is less. They must also restrict the radial deformation of the fitting to 0.1% of the radius of the respective pipe sections. The block must completely surround the fitting for its entire length and circumference (Figure 6-1) and should be placed either against undisturbed earth or backfilled with pipe zone material as appropriate for the native soil characteristics. See sections on Rigid Connections and Concrete Encasement

for details of pipe installation and system layout. These blocks are required for the following fittings when the line pressure exceeds 100 kPA. (See Fig. 6-2)

1. Tees, when the branch pipe is eccentric to the header pipe centerline.
2. Lateral wyes.
3. Bifurcations.
4. Custom fittings as noted by special instructions.

Valves

Valves must be anchored sufficiently to absorb the pressure thrust.

Note: It is not necessary to encase nozzle connections in concrete.

Nozzles are tee branches meeting all the following criteria:

1. Nozzle diameter ≤ 300 mm.
2. Header diameter ≥ 3 times nozzle diameter.
3. If the nozzle is not concentric and/or not perpendicular to the header pipe axis, the nozzle diameter shall be considered to be the longest chord distance on the header pipe wall at the nozzle/pipe intersection.

Concrete Encasement

When pipes must be encased in concrete, such as for thrust blocks, stress locks, or to carry unusual loads, specific limitations in the installation procedures must be observed.

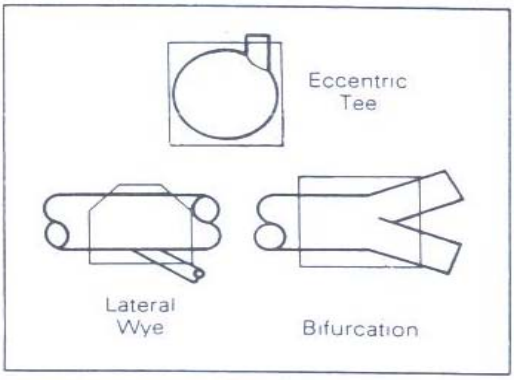


Fig. 6-2 Stress blocked fittings

Pipe anchoring

During the pouring of the concrete, the empty pipe will experience large uplift (flotation) forces. The pipe must be restrained against movement that could be caused by these loads. This is normally accomplished by strapping over the pipe to a base slab or other anchors(s). Straps should be a flat material of minimum 25mm width, strong enough to withstand floatation uplift forces, spaced not to exceed 4 meters, with a minimum of one strap per section. The straps should be tightened to prevent pipe uplift, but not so tight that additional pipe deflection is caused.

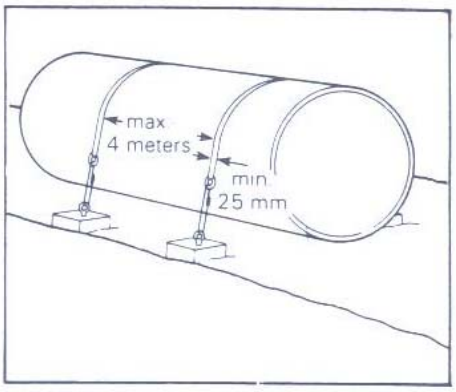


Fig. 6-3 Pipe anchoring

Pipe Support

The pipe should be supported in such a way that the concrete can easily flow completely around and fully underneath the pipe. Also, the supports should result in an acceptable pipe shape (LESS THAN 3% DEFLECTION AND NO BULGES OR FLAT AREAS) and be a lifetime structural material. Supports are normally placed at strap locations (not exceeding 4 meter spacing).

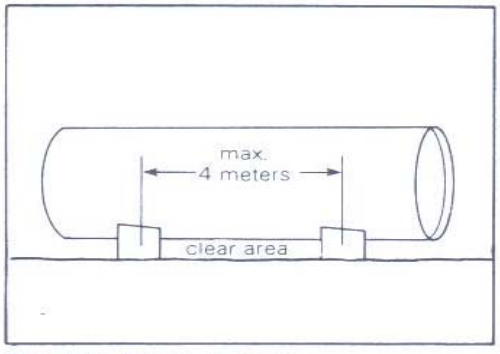


Fig. 6-4 Pipe support.

Concrete Pouring

The concrete surround must be placed in stage allowing sufficient time between layers for the cement to set (no longer exert buoyant forces). Maximum lift height is variable with nominal pipe stiffness as shown on Figures 6-5, 6-6 and 6-7.

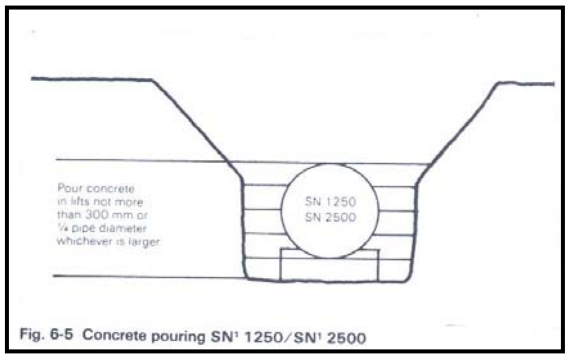


Fig. 6-5 Concrete pouring SN¹ 1250/SN¹ 2500

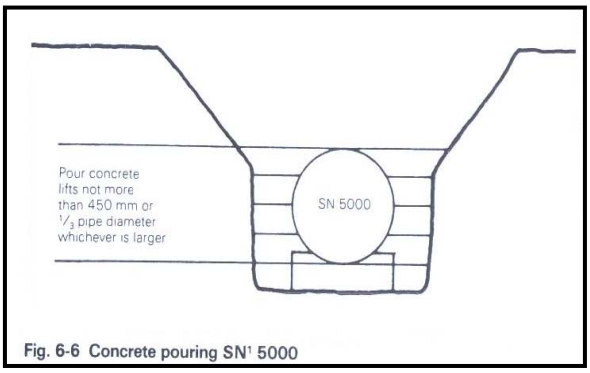


Fig. 6-6 Concrete pouring SN¹ 5000

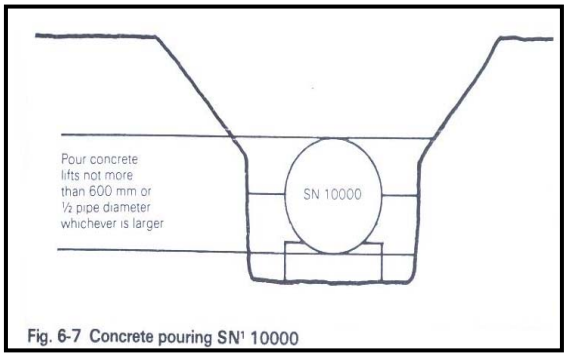
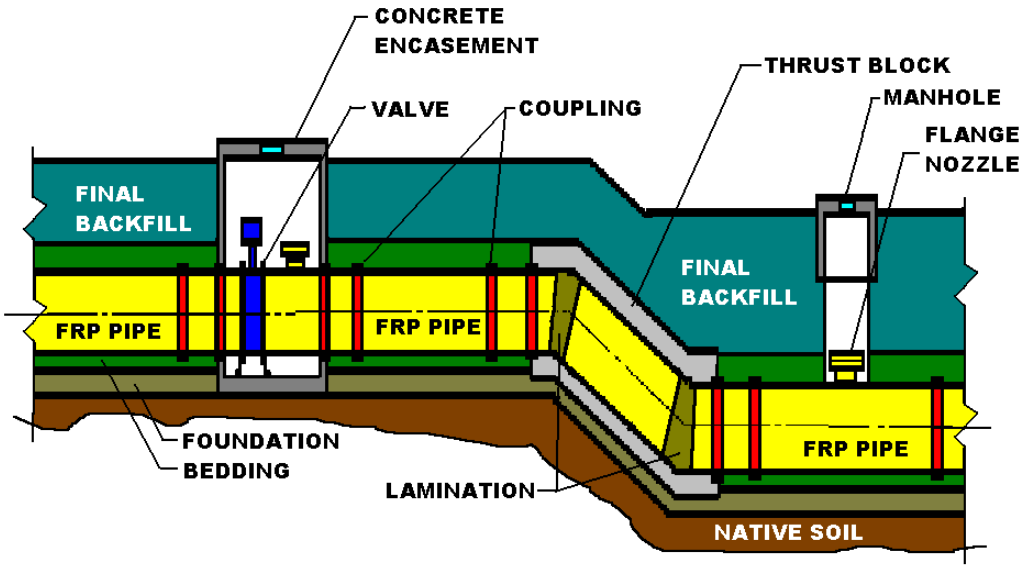


Fig. 6-7 Concrete pouring SN¹ 10000

B.) Sample Installation



SAMPLE PIPE UNDERGROUND INSTALLATION

4.3 JOINING SYSTEM:

The general specification typically adds a classification system for the joints having two general categories. Unrestrained pipe joints can withstand internal pressure but not longitudinal forces. Restrained pipe joints withstand internal pressure and longitudinal forces.

4.3 FIBERGLASS PIPE JOINING SYSTEM

4.3.1 Introduction

There are many joining system, and variations of those systems that meet National Standards requirements and that are available on fiberglass piping products. Many systems meet specific project needs.

Recognize that a given project will require more than one joining system. For example, on a buried pressure pipe project, one may need those joints types.

- Class A, unrestrained joints in the straight run sections.
- Class B, restrained joints at, and adjacent to, the fittings,
- Class B, flanged joints at the valves and pumps.

This discussion of joining system describes many of the joint types available for fiberglass piping systems. The discussion is not exhaustive in that it does not attempt to consider every type of joining system that is presently available. The versatility of manufacture permits differences in configuration and geometry while still meeting performance requirements. We suggest that user contact pipe manufacturers to obtain specific details on joints and joint performance.

4.3.2 Fiberglass joining system classification

The general specification typically adds a classification system for the joints having two general categories, unrestrained pipe joints can withstand internal pressure but not longitudinal forces. Restrained pipe joints withstand internal pressure and longitudinal force.

4.3.2.1 Class A unrestrained pipe joints. Pipe joints can withstand internal pressure but not longitudinal forces.

a.1 Class A.1 Coupling, or bell and spigot, gasket joints. Joints that use an elastomeric seal located in a groove on the spigot or in the bell (coupling) as the sole means to provide fluid tightness. The coupling type joint consists of a length of tubular material with groove and gasket at each end. The coupling is sized such that the pipe slides into it compressing the seal and affecting a seal at each end. The bell and spigot design is similar except that the coupling (bell) is integral at one end of the pipe and the spigot is the other end. The pipe thickness might be increased in the joining area.

This joining system is not able to accommodate longitudinal forces. Figures 8-4 and 8-5 illustrate bell and spigot systems using both single and double gasket designs. The double gasket design applies only to larger diameter pipes. By inserting a part through the bell and between the gaskets, one can test the joint immediately after assembly using pneumatic or hydrostatic techniques.

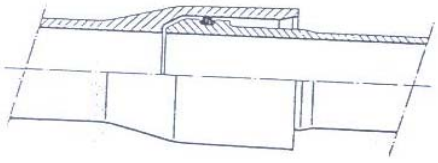


Figure 8-4

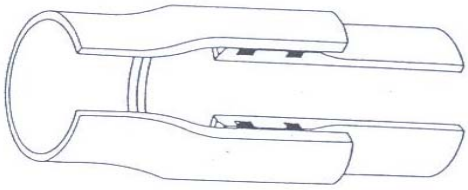


Figure 8-5

Figure 8-6 and 8-7 illustrate coupling joint assemblies. The joint in figure 8-6 uses a gasket mechanically bonded, or molded in the coupling. Figure 8-7 shows a coupling with multiple gaskets restrained in grooves. Both seal against the pipe OD.

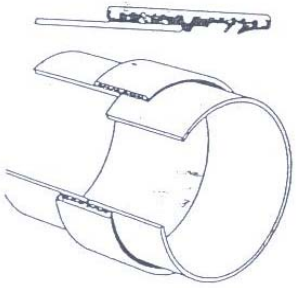


Figure 8-6

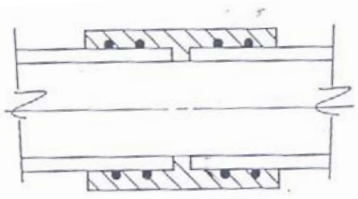


Figure 8-7

Figure 8-8 illustrates a flush joint configuration. That is a joining system in which the pipe ID and OD are continuous rehabilitation slip lining and jacking projects.

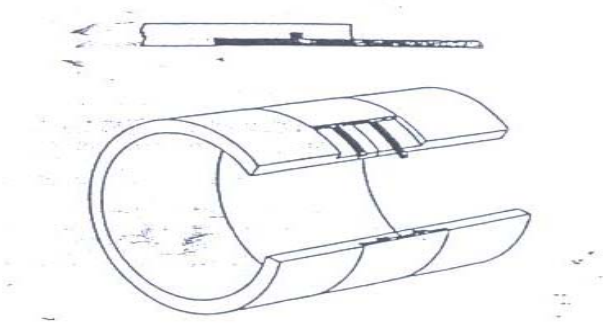


Figure 8-8

a.2 Class A.2 Mechanically coupled Joints

Joints that use mechanically energized elastomeric gasket seals to joint two pieces of pipe. The mechanical coupling techniques applies to plain end pipe. Mechanically coupled joints typically seal on the OD of plain end pipes through the use of gaskets that are loaded mechanically (compressed) to effect the seal.

Figure 8-9 shows a typical mechanically coupled joint. There is no ability to accommodate longitudinal forces in this design.

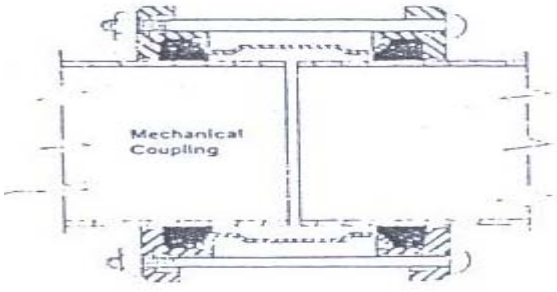


Figure 8-9

b.4 Class B.5 Flanged Joints

Pressure rated flanges are common in the installation of all sizes of fiberglass pipe. Fiberglass flanges often mate with the ANSI/ASME pressure class of bolted flanges.

In the fiberglass case flanges are produced by hand layup, filament winding and compression molding. Compression molding applies to low-pressure class (< 500 psi) small diameter (<8 in.) service.

Project conditions often dictate mating a fiberglass flange with a pre-existing metallic flange on a pump, valve or metallic pipe. Fiberglass flanges should be flat faced or flat faced with a confined gasket. Raised face flanges require an adapter to prevent overstressing – Bolt circles are readily available in standard dimensions and can be made readily to fit special configurations.

Figure 8-19 depicts a fiberglass and fiberglass to steel flanged joint using a flat face gasket.

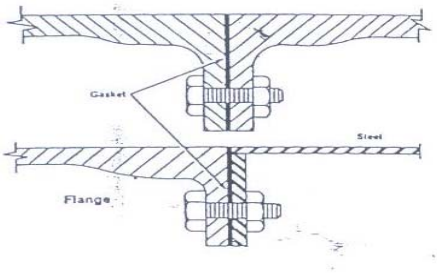


Figure 8-19

Figure 8-20 schematically illustrates the flat faced flanged with groove for a confined gasket which is often used in fiberglass piping systems.

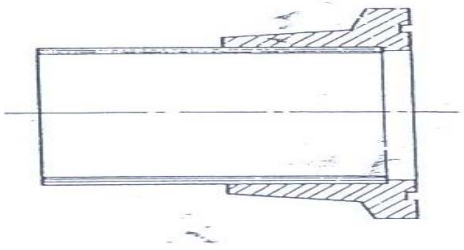


Figure 8-20

Figure 8-21, 8-22 and 8-23 illustrates a variety of flanged fiberglass installations.

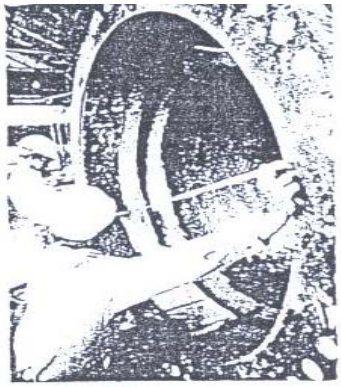


Figure 8-21

Figure 8-22

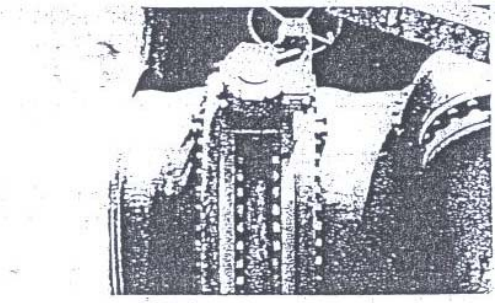


Figure 8-23

Figure 8-21 shows plant technicians checking the dimensions of a 150psi rated 72-inch flange.

Figure 8-21

Figure 8-22

Figure 8-22 is a photograph of a flanged fiberglass pipeline transporting fly ash in a power plant project.

Figure 8-23 is a photograph of fiberglass piping mating with the metallic flanges on a valve in a waste-water treatment plant pumping station.

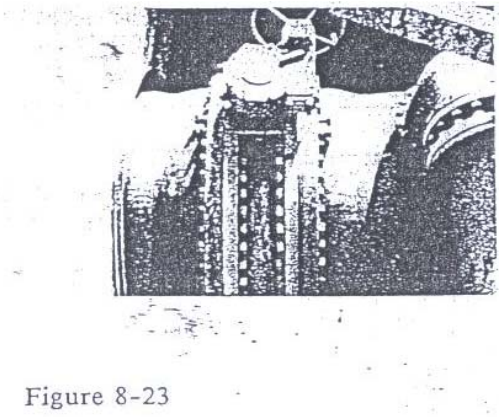


Figure 8-23

Figure 8-24 illustrates the Van stone flange. This variation of the bolted flange is used commonly because of its field flexibility.

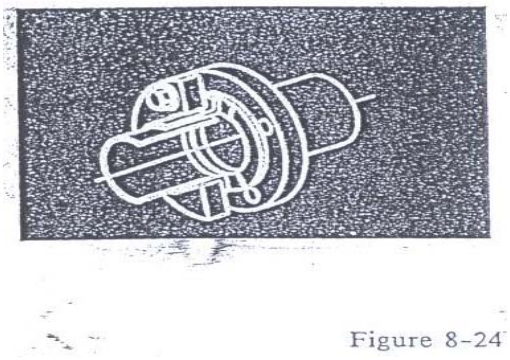


Figure 8-24

Figure 8-25 Illustrates another common flange variation. The smaller OD flange pieces, with a tapered back side and no bolt holes, bond to plain pipe end. Two flanges abut with a gasket in the center. A metallic clamp, with tapered surfaces matching the flanges, draws them together. This variation is typically applies up to 150-psi rated applications in pipe diameters less than 12 inches.

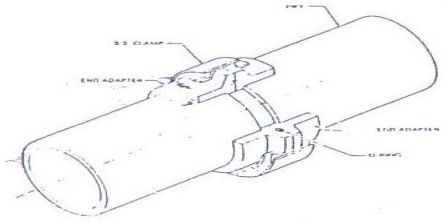


Figure 8-25

b.5. Mechanical joining systems. A number of mechanical joints exist. Mechanical joints exist in both bell and spigot and coupling designs with a variety of threading patterns.

Figure 8-26 shows a bell and spigot design with a fast course threading pattern.

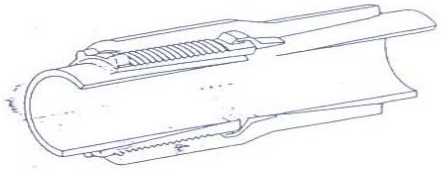


Figure 8-26

Figure 8-27 shows a coupled joint using the PI I round thread profile.

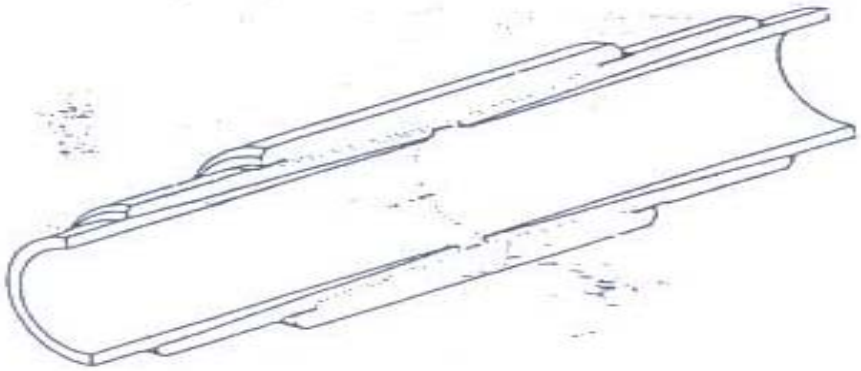


Figure 8-27

JOINING PROCEDURE

1. Thoroughly clean all pipe ends that are to be joined with clean rags and clean solvent to remove any build up of dirt or grease.
2. Immediately prior to joining, use a rotary disc sander to grind the surface of each pipe end a distance of one-half the lay-up width. This procedure should remove the shiny surface of laminate, roughen the pipe surface and remove the remaining dirt for a good joint. This procedure must be repeated if the prepared surface is contaminated prior to fabrication of the lay-up. Contamination would include rain, mud, chemicals, wax, oil, dirt, grease, etc. An alternative to grinding the pipe surface is to sand blast the area to be laid up with a fine angular grit or sand.

   Note: it is to be ensured that the material for lamination and laminate surface shall be protected from dust, sand, fog rain and other contaminants by covering the area around the jointing.
3. Wipe the ground areas with clean solvent and clean rags to remove the collected dust and any surface moisture. The solvent must be allowed to evaporate completely which takes about 5 minutes.

4. Align the pipe sections as perfectly as field condition will permit. Every effort should be made to butt the pieces together as close as possible.

   In some instances, a lateral offset (or "step") may exist at the joint. This offset should be eliminated if possible by adjusting the alignment of the pipes. It the "step" cannot be completely eliminated, then it should be equalized around the circumference of the pipe.

   Note: The tolerance for gap and misalignment between components (pipe/spools) shall be 1/3 of the lesser component thickness. After the

alignment of pipe / spools with in the tolerance limit cab O-sil filler is to be applied between the gaps of two components all around the pipe.

5. In general, joints are made by wetting out with catalyzed resin no more than five plies of chopped mat and woven roving on one of the work tables and lifting these plies and placing them on the pipe. Narrow layers of mat and woven roving are applied first, followed by layers uniformly increasing the width. In this manner, the thickness of the joint is the greatest in the vicinity of the seam and tapers to the edge of the plies.

6. Each joint kit contains the correct number of plies of glass required for your particular job. Each layer will consist of one or more sections to make up the complete layer around the pipe circumference. These sections are pre-cut to a length that can be handled without difficulty.
7. Review the applicable lay-up construction from the attached tables. Note that the total number of plies and that no one layer contains more than plies. Also that each layer begins and ends with a ply of mat.
8. Prepare enough resin for 10 minutes use (use attached tables as a guide) by adding the proper amount of catalyst by volume to the resin in the 1-gallon plastic pots. Add bottom side of the joint. IMPORTANT: Insure the resin and the catalyst temperatures are at minimum 16° C before using.
9. Cover the work table with heavy Kraft paper. Spread a thin layer of catalyzed resin on the paper over an area large enough to include the largest piece of mat or woven roving.

   Note: An alternative to preparing the lay-up on a work table is to we-out the lay-up material directly onto the joint itself. Spread a thin layer of catalyzed resin directly on the prepared pipe surface over an area large enough to include the largest piece of mat or woven roving in the layer. Continue joint fabrication as in point 10, 11 14 and 15.

10. Lay a piece of chopped strand mat on the layer of resin and wet it out with the paint roller. Continue building by alternating mat and woven roving as shown in the attached tables and wetting out each one before applying the next ply. Make sure to center the plies and never we out more plies than what is called for in each layer. Too many plies will not allow proper heat dissipation when the resin is curing and could cause blistering.
11. Roll out all air bubbles and excess resin from the lay-up is to be placed.
12. Apply a coating of catalyzed resin directly on the pipe where the lay-up is to be placed.
13. Center the lay-up on the pre-wetted pipe joint making sure the first chopped strand mat lies directly on the pipe. Again, roll out all the air bubbles with the grooved roller. Cease rolling at least as soon as the resin begins to gel.
14. Continue this procedure until all the sections of the first layer have been applied. Make sure the sections overlap at least five (5) cm. Let this lay-up cure until it is comfortable to touch with the bare hand.
15. Continue using the same procedures with the remaining layers. CAUTION: Stagger the 5cm overlaps so that they will not fall in line. Insure that the first and last plies of the total lay-up are chopped strand mat.
16. Internal lamination is not applicable on this project for the pipe/spools diameter less than 36".

5.4

17. Thoroughly clean all pipe ends that are to be joined with clean rags and clean solvent to remove any build up of dirt or grease.
18. Immediately prior to joining, use a rotary disc sander to grind the surface of each pipe end a distance of one-half the lay-up width. This procedure should remove the shiny surface of laminate, roughen the pipe surface and remove the remaining dirt for a good joint. This procedure must be repeated if the prepared surface is contaminated prior to fabrication of the lay-up. Contamination would include rain, mud, chemicals, wax, oil, dirt, grease, etc.

An alternative to grinding the pipe surface is to sand blast the area to be laid up with a fine angular grit or sand.

Note: it is to be ensured that the material for lamination and laminate surface shall be protected from dust, sand, fog rain and other contaminants by covering the area around the jointing.

19. Wipe the ground areas with clean solvent and clean rags to remove the collected dust and any surface moisture. The solvent must be allowed to evaporate completely which takes about 5 minutes.
20. Align the pipe sections as perfectly as field condition will permit. Every effort should be made to butt the pieces together as close as possible.

    In some instances, a lateral offset (or "step") may exist at the joint. This offset should be eliminated if possible by adjusting the alignment of the pipes. It the "step" cannot be completely eliminated, and then it should be equalized around the circumference of the pipe.

    Note: The tolerance for gap and misalignment between components (pipe/spools) shall be 1/3 of the lesser component thickness. After the alignment of pipe / spools with in the tolerance limit cab O-sil filler is to be applied between the gaps of two components all around the pipe.

21. In general, joints are made by wetting out with catalyzed resin no more than five plies of chopped mat and woven roving on one of the work tables and lifting these plies and placing them on the pipe. Narrow layers of mat and woven roving are applied first, followed by layers uniformly increasing the width. In this manner, the thickness of the joint is the greatest in the vicinity of the seam and tapers to the edge of the plies.
22. Each joint kit contains the correct number of plies of glass required for your particular job. Each layer will consist of one or more sections to make up the

5.3

complete layer around the pipe circumference. These sections are pre-cut to a length that can be handled without difficulty.

23. Review the applicable lay-up construction from the attached tables. Note that the total number of plies and that no one layer contains more than plies. Also that each layer begins and ends with a ply of mat.
24. Prepare enough resin for 10 minutes use (use attached tables as a guide) by adding the proper amount of catalyst by volume to the resin in the 1-gallon plastic pots. Add bottom side of the joint. IMPORTANT: Insure the resin and the catalyst temperatures are at minimum 16° C before using.
25. Cover the work table with heavy Kraft paper. Spread a thin layer of catalyzed resin on the paper over an area large enough to include the largest piece of mat or woven roving.

    Note: An alternative to preparing the lay-up on a work table is to we-out the lay-up material directly onto the joint itself. Spread a thin layer of catalyzed resin directly on the prepared pipe surface over an area large enough to include the largest piece of mat or woven roving in the layer. Continue joint fabrication as in point 10, 11 14 and 15.
26. Lay a piece of chopped strand mat on the layer of resin and wet it out with the paint roller. Continue building by alternating mat and woven roving as shown in the attached tables and wetting out each one before applying the next ply. Make sure to center the plies and never we out more plies than what is called for in each layer. Too many plies will not allow proper heat dissipation when the resin is curing and could cause blistering.
27. Roll out all air bubbles and excess resin from the lay-up is to be placed.
28. Apply a coating of catalyzed resin directly on the pipe where the lay-up is to be placed.

29. Center the lay-up on the pre-wetted pipe joint making sure the first chopped strand mat lies directly on the pipe. Again, roll out all the air bubbles with the grooved roller. Cease rolling at least as soon as the resin begins to gel.
30. Continue this procedure until all the sections of the first layer have been applied. Make sure the sections overlap at least five (5) cm. Let this lay-up cure until it is comfortable to touch with the bare hand.
31. Continue using the same procedures with the remaining layers. CAUTION: Stagger the 5cm overlaps so that they will not fall in line. Insure that the first and last plies of the total lay-up are chopped strand mat.
32. Internal lamination is not applicable on this project for the pipe/spools diameter less than 36".

a.1.1 LAY-UP PROCEDURE FOR [POLYESTER AND VINELESTER] FIBERGLASS REINFORCED PLASTIC (FRP) PIPE.

FIELD CONDITIONS

1. Dampness

The lay-up joint must be fabricated in dry conditions since any dampness on the pipe surface will cause poor bond. Therefore,, precautions must be taken during wet weather. A portable shelter that will fit around the pipe will be joined if dampness is present. The pipe and joint must be kept completely dry until the joint has cured.

2. Hot Weather Work

As mentioned earlier, the gel time decreases as the air temperature increases. In certain situation, this property is beneficial. However, above ambient temperature of 38°C the gel time is very short. This will cause the resin to set before the air bubbles can be rolled out. Therefore, joints should not be fabricated when ambient temperatures above 38°C are

expected. When working in direct sunlight above 27°C, the work area should be shaded with a sun screen to allow uniform working time and curing of the lay-up around the pipe.

3. Cold Weather Work

On the other hand, the gel time will increase as the air temperature decreases 16° C is the minimum outside air temperature that the resin, mixed with the proper amount of catalyst, will gel in 2 reasonable length of time. If air temperatures at the job site are expected to be below 16° C then a heated shelter will be required to bring the air temperature surrounding the joint above 16° C. The temperature of the resin must also be kept above 16° C in order for it to cure properly. For making lay-ups in cold weather, it is recommended that drum heaters be used to keep the resin at approximately 16° C. the catalyst should be stored inside away from direct heat or flames and maintained at approximately 16° C along with the glass required for the lay-up.

The pipe in the area of the lay-up should be maintained at 16° C. For this, an industrial heating blanket used prior to making the lay-up should be effective. Other heat sources which can be used include hot air blowers or heat lamps. Salamander or heaters with open flames or heating elements are not recommended for use around resin mixing, lay-up areas or storage areas.

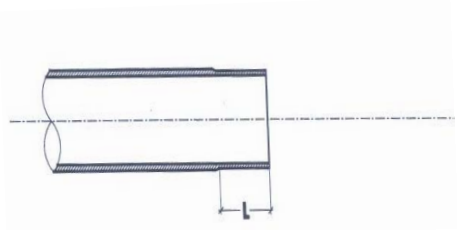
a.1.2 - LAY-UP PROCEDURE FOR REINFORCED THERMOSETTING RESIN PIPES (RTR) / GLASS REINFORCED EPOXY PIPES (GRE)

1. PIPE END PREPARATION: Pipe cutting

   Note: This initial step shall be applicable only if a factory-prepared pipe end needs to be cut and replaced, or a pipe length requires field adjustment. Mark the pie section to be cut using a wrap-around and a white marker. Cut the pipe using a hacksaw or a cutting disc; make sure that a proper square cut has been made.

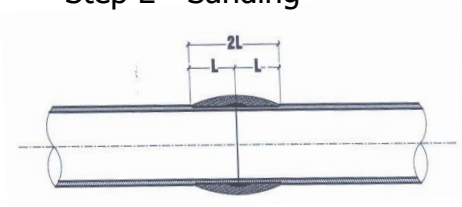
2. The required lamination length is to be prepared for sanding and grinding. For straight joint but and wrap, sandblast or sand the lamination area until the resin-rich topcoat is removed and clear fiberglass becomes visible; clean the total external surface of the pipe sections to be laminated. Sand or grind the cross section of the pipes (the cut ends) as well.

Step 1 - Cutting



Step 2 - Sanding

Step 3 – Fit Layer



Step 4 – Lamination

3. ADHESIVE FIT LAYER:-Position the pipe sections for jointing. Prepare the adhesive mixture. Coat the cut ends with adhesive in order to protect them against penetration of the medium. Coat the external surfaces of the pipe ends approximately 100mm. in width, and joint them together. Wet out the boat tape with adhesive and apply a minimum of 3 layers circumferentially onto the jointed pipe ends. Use a heating blanket to cure the initial laminate for one hour. Sand the surface after curing before proceeding to the following step. Prepare all equipment and construction materials required for the joint lamination for estimated material requirements per joint size. Do not use humid or damp fiberglass materials; use hot-air guns or oven-dry the fiberglass fabrics before use.
4. Start the lamination of the fitted sections within two hours after sanding or tapering; re-sanding of the lamination area shall be required if the waiting period exceeds two hours. Remove any possible dew by slightly heating the pipe ends from the inside by a heating blanket.
5. Prepare the resin mix using the correct mixing ration – Resin= 100 Parts by Weight; Hardener = 24 Parts by Weight. Take note of the pot life after mixing. The amount of the mixture depends on the diameter. Several batches could be used depending on the weather, temperature and gelling time.
    a. Be sure that the curing agent is carefully mixed with the resin. The temperature of the resin and curing agent mixture should not exceed 25° C.
    b. For the hand lay-up of the laminate structure, use boat tape and woven roving in the sequence and with 50% overlap until the minimum required laminate thickness is achieved.
    c. Make sure that each applied layer of boat tape or woven roving is thoroughly impregnated with the resin mixture.

d. Apply the layers in a circumferential direction onto the pipe-joint ends. During the wrapping process, tension must be applied so that the resin under the layer being laid could be pressed out.
e. Avoid air getting into the laminate by using the air-relieve rollers continuously. To give the finishing touch, apply one final layer of boat type spirally wrapped onto the whole surface of the laminate. Use air-relieve rollers to avoid air enclosures.
f. After the final boat tape layer, smooth out the resin from the exterior of the laminate, using a rubber scraper, to leave a resin-rich surface.
g. Before curing, use a heat source (hot-air blower, flood light etc.) to allow the laminate to gel.
h. Curing and finishing:-Use heating blankets to cure the butt and wrap joint laminate
i. Check heating blankets if it is working properly. Temperatures in excess of 120°C should be easily achieved if the heating blanket works properly. The surface contact between the heating blanket and the laminate should be as large as possible; fit the blanket as snugly as possible to the joint.
5.6
j. Cure the laminate for 4 hours minimum. Wherever possible, apply a heating blanket on the inside as well as close the pipe ends to avoid drafts.
k. In cold weather, insulate the heating blanket to trap the heat but do not cover the blanket's thermostat housing.
l. After curing, use sandpaper to remove the rough edges of the laminate and to generally smooth out the external surface.

QUALITY CONTROL

Quality Statement

Ajyal Ltd Co is committed to providing the highest quality services to customers in the most comprehensive way. This is of fundamental importance to the continued success of Ajyal Ltd Co.

Tests are carried out to establish conformance as early and as often as required. The requirement for inspection and test and the acceptance criteria are detailed on the appropriate process documentation the results of inspection and tests are recorded. The details of non-conforming products are recorded and the product identified and held until corrective action implemented. A definite intervals on non-conformances are reviewed, analyzed and where defects are identified long term corrective actions are devised to prevented further recurrences

RECORDING AND DOCUMENTATION

Documents procedures are maintained to control all inspection and tests performed to verify that service or activity conforms to specified requirements and perform satisfactorily.

In the field installation, inspector records the pipe and fittings being installed, tested and other activities in the site.

Acceptances, non-conformance reports, certifications of testing, compliances and other pertinent papers are been officially documented. Signature of the concerned parties including the inspector been affixed always in the document.

Inspector always secure his copy of all important documents that are relevant to his work for his perusal and for company's reference, that are maintained during the whole period of the project or assignment.

Following visual defects are seen on the pipes and butt & wrap joints.

DEFECTS	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Air bubbles, Voids (Entrapped air in and between glass plies)	Application of too many plies of glass at one time Inadequate rolling between applications Vigorous mixing causing incorporation of air into resin High viscosity resin used in combination with thick glass	Apply fewer plies at one time and roll thoroughly Reduce mixing speed Resin viscosity can be reduced by adding 3-5% styrene
Blisters (Round, elevated areas of varying sizes on laminate surface, may occur individually or in a group	Too rapid cure with high exotherm may cause separation at mat surfaces Presence of moisture in glass, resin, or filler	Reduce exotherm of resin system by laying up fewer plies at one time Reduce exotherm by lowering DMA or catalyst level Insure proper storage of resin, glass, and filler, away from sources of moisture
Crack (Cracks running along laminate either on or just below the surface)	Overly resin-rich areas Cracks may result from dramatic changes in the temperature conditions of the equipment (thermal shock cracking) Resin shrinkage during cure	Reduce resin content Monitor and minimize temperature fluctuations during equipment operation
Delamination (Separation of glass layers, occurs particularly in areas of high stress; i.e., small-diameter pipe, knuckle joints, etc.	Inadequate saturation of glass with resin Application of two layers of woven roving with no chopped mat in between Application of laminate to an FRP surface that has been allowed to cure several weeks Use of rapid cure systems in small radii areas	Insure glass is completely saturated with resin and roll thoroughly Always use alternating layers of woven roving and chopped mat Before applying another FRP layer, lightly sand areas that have been cured for long periods of time In tight radii areas, use a low exotherm system to reduce resin shrinkage and stress build-up
Dry Spots (Areas where dry glass fibers are protruding from laminate)	Not thoroughly saturating glass with resin	Thoroughly saturate glass with resin and roll thoroughly
Fish eye (Mass of foreign material on or near the laminate surface; mass is not blended into surrounding material)	Dirty glass Contamination of resin with foreign material	Insure fabricating area is clean Properly store resin and glass to eliminate contamination

Jackstrawing (initially, laminate appears clear, but as curing occurs, white blemishes appear in the laminate, individual glass fibers become prominent and turn white	Incompatibility between resin and glass binder; as resin cures, binder "phases out", causing white cloudy appearance of laminate	Thoroughly evaluate compatibility of resin and glass binder before beginning fabrication
Pimple (Small, raised area on laminate surface)	Dripping resin onto a laminate surface that has already begun to cure Rolling a laminate surface that has begun to cure	Thoroughly roll out laminate before resin begins to cure Do not continue rolling if resin is beginning to cure
Scorching / Burning (Discoloration of laminate as it cures)	Generation of very high exotherm temperatures due to one or a combination of the following – hot working temperatures, high DMA and/or catalyst levels, laying up too many plies at one time	Reduce DMA and/or levels particularly if working temperatures are high Reduce number of plies laid up at one time and allow to cure before applying additional layers
Spotty Cure (Laminate surface is soft in some areas while cured hard in others)	Incomplete or inadequate mixing of promoters and/or catalyst	Adjust mixing to achieve a small vortex and good movement of resin surface Mix thoroughly after addition of each additive Dissolve cobalt in small amount of styrene before adding to resin
Tacky Surface (Laminate surface is tacky to the touch or fails to pass acetone sensitivity test)	Incomplete cure caused by air inhibition Cobalt level too low	Apply a resin/wax topcoat to tacky surface Do not use a resin/wax topcoat if additional bonding is to be done to the surface Increase cobalt level
Wrinkle (Crease or wrinkle of glass on or near the laminate surface)	Wrinkling of veil (particularly synthetic veil) or glass can occur when laminating or over uneven surface or when using stiff, heavy glass in corners	Use 1 oz. (300 gm^2) or $1^{1/2}$ oz. (450 g/ m^2) mat where wrinkling is a problem Reduce resin viscosity by adding 3-5% styrene

LOCAL AND INTERNATIONAL STANDARDS

ASTM D2310	Standard Classification for Machine Made Reinforced Thermosetting Resin Pipe
ASTM D2996	Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe
ASTM D3262	Standard Specification for Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3517	Standard Specification for Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Pressure Pipe
ASTM D3754	Standard Specification for Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe
ASTM D4024	Standard Specification for Reinforced Thermosetting Resin (RTR) Flanges
ASTM D4161	Standard Specification for Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F1173	Standard Specification for Epoxy Resin Fiberglass Pipe and Fittings to be used for Marine Application
ASTM D2563	Standard Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts
ASTM D3839	Standard Practice for Underground Installation of Flexible Reinforced Thermosetting Resin Pipe and Reinforced Plastic Mortar Pipe
ASTM D1599	Short Term Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings
ASTM D2925	Measuring Beam Deflection of Reinforced Thermosetting Plastic Pipe Under Full Bore Flow
ASTM D2992	Obtaining Hydrostatic Design Basis for Reinforced Thermosetting Resin Pipe and Fittings ASTM D1598 Time to Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D2412	External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
ASTM D2924	External Pressure Resistance of Reinforced Thermosetting Resin Pipe
ASTM D696	Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 ºC and 30 ºC
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D448	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12 in (305 mm) drop
ASTM D1557	Moisture Density Relations of Soils and Soil-Aggregate Mixture (Modified Proctor Test)
ASTM D1586	Penetration Test and Split-Barrel Sampling of Soils
ASTM D2166	Unconfined Compressive Strength of Cohesive Soil
ASTM D2435	One-Dimensional Consolidation Properties of Soils
ASTM D2487	Standard Test Method for Classification of Soils for Engineering Purposes
ASTM D2488	Standard Practice for Description and Identification of Soils
ASTM D4253	Test Method for Maximum Index density of Soils Using a Vibratory Plate
ASTM D4254	Test Method for Minimum Index density of Soils and Calculation of Relative Density
ASTM D653	Definition of Terms Relating to Soil and rock Mechanics

ASTM F704	Standard Practice for Selecting Bolting Lengths for Piping System Flanged Joints

American Society of Mechanical Engineers (ASME)

ASME B31.3	Chemical Plant and Petroleum Refinery Piping
ASME RTP-1	Reinforced Thermoset Plastic Corrosion Resistant Equipment
ASME Section X	Boiler and Pressure Vessel Code

American Water Works Association (AWWA)

AWWA C950	Standard for Fiberglass Pressure Pipe
AWWA M45	Manual of Fiberglass Pipe Design

American Petroleum Institute (API)

API 15LR	Specification of Low Pressure Fiberglass Line Pipe
API 15HR	Specification of High Pressure Fiberglass Line Pipe
API 15AR	Specification for Fiberglass Tubing
API RP15L4	Recommended Practice for Care and Use of Reinforced Thermosetting Resin Line Pipe
API RP15A4	Recommended Practice for the Care and Use of Reinforced Thermosetting Resin Casing and Tubing
API 1615	Installation of Underground Petroleum Storage Systems

British Standards Institution (BS)

BS 7159	Non-Destructive Testing

American National Standards Institute (ANSI)

ANSI B16.2	Cast-Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	
ANSI B16.21	

U.S. Military Specifications

MIL-P-24608	Specification for epoxy resin pipe from ½ through 12 inch diameters for 200 psig service at 150 ºF
MIL-P-28584A	Specification for epoxy resin pipe and fittings from 2 through 12 inches diameter for use in continuous service at 125 psig and 250 ºF
MIL-P-29206	Specification for epoxy or polyester pipe and fittings 2 through 12 inches in diameter for service to 150 ºF and 150 psig with surges to 250 psig

Other Standards

UKOOA	UK Offshore Operators Association Specification and Recommended Practice for the use of GRP Piping Offshore

LOCAL CODES AND STANDARDS

Sabic Engineering Standards (SES)

SES P01-E28-01	Qualification of FRP Piping and Components
SES P01-E28-02	Design Requirements for Aboveground FRP Piping Systems
SES P01-E28-03	Design Requirements for Underground FRP Piping Systems
SES P13-C05	Installation Requirements for FRP Piping Systems
SES P14-T02	Quality Assurance for FRP Piping

Saudi Arabian Standards Organization (SASO)

SASO-1577	Gravity Sewer
SASO-1578	Pressure Sewer
SASO-2221	Method for Fiberglass Reinforced Resin Pipes

National Sanitation Foundation. Standard No. 14 and 61.
Tests and lists fiberglass pipe, fittings and adhesives for use in conveying potable water. Additionally tests and certifies products as to their classification to an applicable national standard or for special properties (Standard 14 only).

Underwriters Laboratories, Inc
Has established standards for testing and listing fiberglass pipe for use as underground fire water mains and transport of petroleum products.

Factory Manual Research.
Has established an approval standard for plastic pipe and fittings for underground fire protection.

ANSI/ASME B31.3 Chemical Plant and Petroleum Refinery Piping Code.
This code lists ASTM, AWWA and API fiberglass pipe specification as being acceptable for use within the code and establishes criteria for their installation and use. This code, as does all other ASME codes, establishes rules regarding the application of fiberglass piping and provides engineering guidance for the use of fiberglass materials.

ANSI/SME B31.8 Gas Transmission and Distribution Piping Code.
This code lists fiberglass pipe manufactured in compliance with ASTM D2517 as being acceptable for use within the code.

Department of Transportation, Title 49, Part 192.
Code of Federal Regulations covering the transportation of natural and other gases by pipeline. Minimum federal standards.

ASME Boiler and Pressure Vessel Code Case N155.
This code provides the rules for the construction of fiberglass piping systems for use in the Section III, Division I, Class 3 applications in nuclear power plants.

AJYAL LIMITED COMPANY
Engineering Fiberglass Piping System,
Erection Maintenance Contractors and General Services

ON SITE Q.C. INSPECTION SHEET
FOR BUTT & WRAP JOINT

PROJECT NAME: ..... UNIT / AREA NO: .....

CLIENT: .....

CONSULTING ENGINERING: .....

DRAWING NO: .....

LINE NO: ..... DATE OF JOINTING: .....

JOINT NO: ..... INSTALLATION TYPE: .....

DIAMETER: ..... PRESSURE: ..... RESIN: .....

EXTERNAL LAY-UP

DESCRIPTION	ACT. VALUE	PASS	FAIL	REMARKS
CUTTING				
GRINDING				
ALIGNMENT				
ASSEMBLY				
LAY-UP THICKNESS				
LAYER WIDTH				
BARCOL HARDNESS				
VISUAL INSPECTION				

INTERNAL LAY-UP

DESCRIPTION	ACT. VALUE	PASS	FAIL	REMARKS
GROOVING				
LAY-UP THICKNESS				
LAYER WIDTH				
BARCOL HARDNESS				
VISUAL INSPECTION				

REMARKS:_____
_____
_____

AUTHORIZED REP. OF	NAME	SIGNATURE	DATE
CONTRACTOR			
CONSULTING ENGINEER			
AJYAL LTD. CO.			

AJYAL LIMITED COMPANY
Engineering Fiberglass Piping System,
Erection Maintenance Contractors and General Services

PROJECT SITE Q.C. INSPECTION SHEET

Q.C. 001.07

PROJECT NAME: ..... UNIT / AREA NO: .....

CLIENT: .....

CONSULTING ENGINERING: .....

DRAWING NO: ..... TYPE OF JOINT: FLANGE TO FLANGE

LINE NO: ..... DATE OF JOINTING: .....

JOINT NO: ..... INSTALLATION TYPE: .....

DIAMETER: ..... PRESSURE: .....

FLANGE TO FLANGE

DESCRIPTION	PASS	FAIL	REMARKS
ALIGNMENT			
GASKET			
BOLTING SEQUENCE			
BOLTING TORQUE VISUAL INSPECTION			

REMARKS:_____
_____
_____

AUTHORIZED REP. OF	NAME	SIGNATURE	DATE
CONTRACTOR			
CONSULTING ENGINEER			
AJYAL LTD. CO.			

PROJECT SITE Q.C. INSPECTION SHEET

Q.C. 002.07

PROJECT NAME: ..... UNIT / AREA NO: .....

CLIENT: .....

CONSULTING ENGINERING: .....

DRAWING NO: ..... TYPE OF JOINT: ADHESIVE

LINE NO: ..... DATE OF JOINTING: .....

JOINT NO: ..... INSTALLATION TYPE: .....

DIAMETER: ..... PRESSURE: .....

BELL & SPIGOT

DESCRIPTION	PASS	FAIL	REMARKS
END PREPARATION			
CLEANLINESS & DIRT REMOVAL			
EPOXY MIX CONDITION			
JOINT ALIGNMENT & STABILITY			

REMARKS:_____
_____
_____

AUTHORIZED REP. OF	NAME	SIGNATURE	DATE
CONTRACTOR			
CONSULTING ENGINEER			
AJYAL LTD. CO.			

ON HOLD REPORT

Q.C. 001.07

PIPE NO.: ..... DATE: .....

DEFECTS .....

ACTION TAKEN .....

SIGNATURE .....

ON HOLD REPORT

Spool NO.: ..... DATE: .....

DEFECTS .....

ACTION TAKEN .....

SIGNATURE .....

SAFETY POLICY

AJYAL LTD. CO. is committed to insure the health and safety at work of all its employees. This commitment extends to the provision of human and material resources necessary for the proper discharge of its own statutory duties and for the proper discharge of the duties and responsibilities of its managers, Supervisors and workforce in connection with health and Safety at work.

The management expects that all its employees will act in a responsible manner and fully cooperate in the implementation of the company safety policy and in ensuring that safe working is an integral part of each and every task.

ARRANGEMENT FOR MAKING THE POLICY EFFECTIVE

The basis of the corporation arrangements for making its policy effective lies in its strict observance of the requirements of the relevant standard specifications, the various statutory enactment and approved Codes of practice in all its operations. The following items are included in these arrangements:

a) Personal Protection

It is a condition of employment that all staff must be aware of the protective equipment provided. This consists of a safety helmet, overall, gloves, and where appropriate, eye protection and safety footwear. This condition extends to the use of any other protective equipment, which may be specified from time to time.

b) First Aid

Trained and certified aides are appointed at the sites with fully equipped first aid boxes for treatment of minor injuries. On outlying sides, it is a normal part of the contract of the First Aid facilities to be provided by the client. Where this is not the case, equipment is provided and a first aide appointed.

c) Accident Reporting

All accidents, no matter how slight, are reported. Every accident is investigated; reports of injuries are entered in to the register kept for that purpose at every site office. The repots of investigations are kept in file at Head Office.

Fire fighting equipment and fire alarms are installed at the Head Office site in accordance with the advice from Fire Services and provision of the current Fire Certificate. Instructions with regard to fire fighting and evacuation procedures are placed at strategic points. Fire extinguishers and fire instructions are placed in each office, mess room, changing room, etc. on all outlying sites.
Equipment is maintained by the supplier. Alarm and evacuation procedures are tested regularly.

d) Transport

Establishment owned transport is maintained and inspected at least to test requirements by their Resident maintenance Engineer based at Head Office site. Contracts for hired vehicles include the provisions of maintenance and inspection service.

SAFETY AT THE TIME OF BUTT AND WRAP JOINT

1) Goggles or safety glasses should be worn at all times and by all personnel in the vicinity of the lay-up operations.
2) The skin of all persons handling the materials should be protected with rubber gloves, long sleeve shirt, long pants and hats of some kind.
3) The chemicals are extremely flammable and shock sensitive. Care should be taken that they are kept away from open flames or sparks and that they are stored separately away from work areas and other flammable materials. They should also be protected from heat and sunlight.
4) Over catalyzed resin call spontaneously burst into flames. If any pot of resin is seen smoking, it should immediately remove away from all work areas to safe place where, if it does ignite, the burning will not do any damage.

   Note: Work force should ensure that they discard the dried/gelled resin and other waste into water container.
5) A "NO SMOKING RULE' should vigorously be enforced in all areas where lay-ups are being made.
6) In enclosed spaces and sometimes close to outdoor lay-ups, vapors from the resin and /or solvent can reach explosive concentrations. For this reason open flames are kept away at all times and explosion proof electric motors and incandescent lights must be used.
7) Approved vapor respirator should be worn along with adequate ventilation when working with resin catalyst and solvent in a confined area such as a weather proof shelter.

SAFETY AT THE TIME OF MATERIAL HANDLING AND STORAGE

1) Keep chemicals in clean shaded area
2) Keep clear sign (fire hazardous) at the chemicals storage area.
3) Keep unused chemicals containers closed.
4) Always accommodate good house keeping.
5) Caution should be observed in all catalyzed resin batches particularly "hot" mixtures involving higher catalyst amounts. These release the heat of reaction more rapidly and consequently peak at higher temperatures than the slower mixtures. In very "hot" batches, ignition temperatures can be reached and due caution should be exercised in their use. Any pot of reacting mixture or any 8.2 which has been spilled which beings to smoke must immediately be removed to a safe place where it will not do any damage if it ignites.

CHECK LIST

The basic materials provided to site in-charge, during mobilization of manpower, which is required for installation and erection job.

EQUIPMENT	QUANTITY	RECEIVED (√)
Measuring Tape		
Electrical grinder w/ grinding discs (Big)		
Electrical Grinder w/ grinding discs (Small)		
Cutting Discs (Big)		
Cutting Discs (Small)		
Stirring wooden sticks		
Plastic cup (1 kg)		
Steel rollers		
Woolly rollers		
Scrapper		
Pi Tape w/ vernier division		
Torque wrenches		
Calipers		
Screw gauges		
Miracle point		
Exhaust fan		
Marker		
Water level		
Electrical extension cord		
Heating blanket & hot air blower		
Spigot shaving tools (pipe shaver)		
Laminate curing hardness device		
Electrical or pneumatic drilling machine (small)		
Drilling bits		
Rubber mallet		
Key-lock remover		
Plunger Gun		
Vegetable soap		
Winches (come along jack)		
Band clamp w/ puller rings		

Rubber pads		
Lifting straps		
Hack saw or Power Jig saw		
Flapper wheel sanders or coarse emery cloth; grid 60		
Pipe fitters wrap around, white paint pencil		
Masking tape		

SAFETY MATERIALS	**QUANTITY**	**RECEIVED (√)**
Helmet		
Safety shoes		
Overall		
Safety glass		
Safety masks		
Safety belt		
Working gloves		
Rubber gloves		
Cotton gloves		
Barricading tape		
Safety sign display boards		

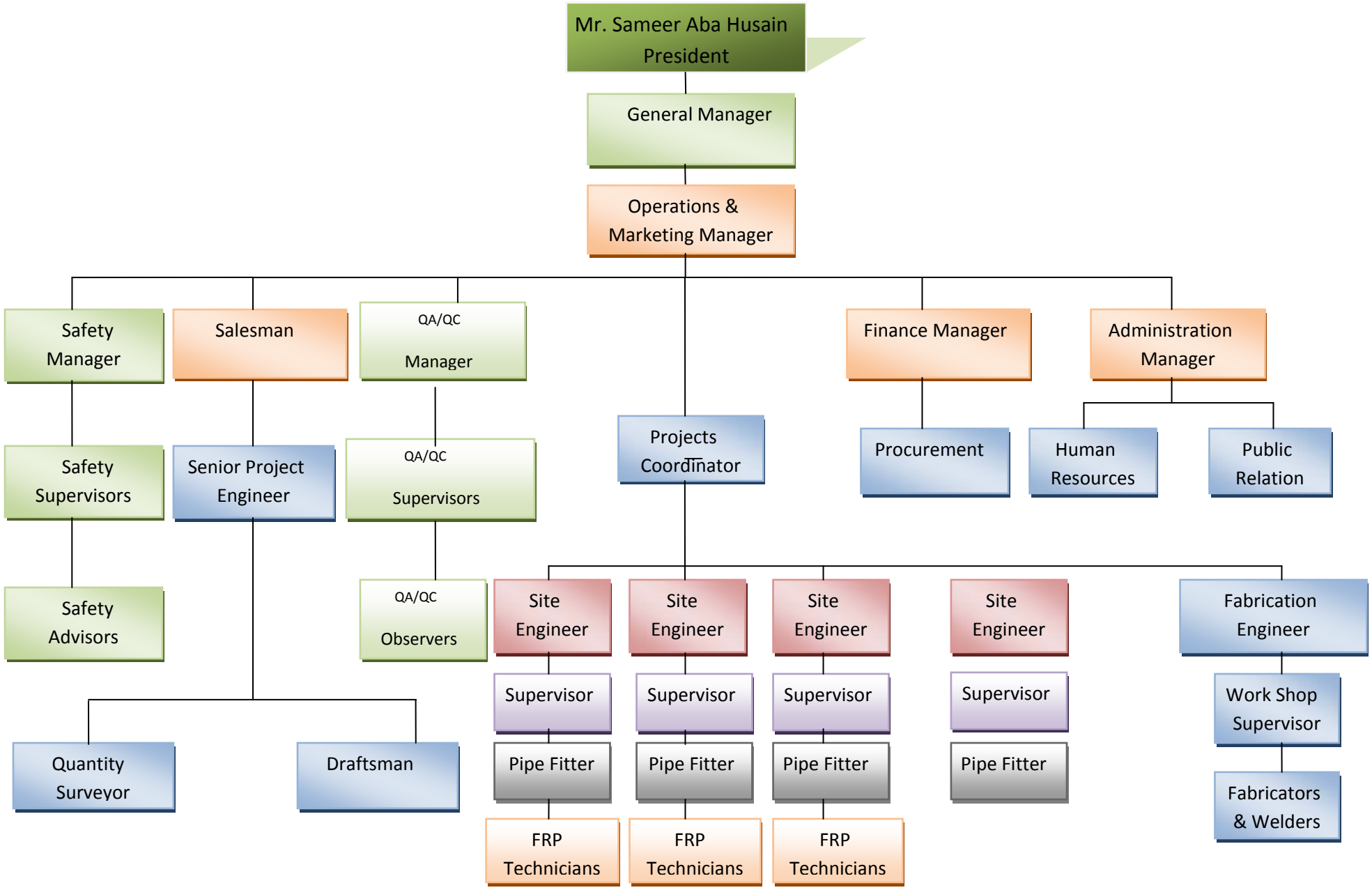
RAW MATERIALS	**QUANTITY**	**RECEIVED (√)**
Resin		
Catalyst or Hardener		
Styrene		
Thinner		

TRANSPORTATION	**QUANTITY**	**RECEIVED (√)**
Pickup		

Above mentioned materials with checked mark (√) is received.

Site Engineer Signature

Foreman Signature


Mr. Sameer Aba Husain
President
General Manager
Operations & Marketing Manager
Safety Manager
Salesman
QA/QC Manager
Finance Manager
Administration Manager
Safety Supervisors
Senior Project Engineer
QA/QC Supervisors
Projects Coordinator
Procurement
Human Resources
Public Relation
Safety Advisors
QA/QC Observers
Site Engineer
Site Engineer
Site Engineer
Site Engineer
Fabrication Engineer
Supervisor
Supervisor
Supervisor
Supervisor
Work Shop Supervisor
Quantity Surveyor
Draftsman
Pipe Fitter
Pipe Fitter
Pipe Fitter
Pipe Fitter
Fabricators & Welders
FRP Technicians
FRP Technicians
FRP Technicians

List of Projects for AJYAL Ltd. Co.

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
1	Al-Khobar Desalination Plant Phase-III	Saline Water Conversion Corp. (S.W.C.C)	Hitachi Zosen Corporation (Japan)	Supply of FRP pipes/spools site connections, supervision and inspection. (Adhesive, Butt & Wrap)	20-2300 mm
2	Shoaiba Power Plant Phase-II Lot 1B	Saline Water Conversion Corp. (S.W.C.C)	Consolidate Contracting Co. (C.C.C)	Butt Wrap Site connections Pre-Insulated pipeline Butt Wrap connections for carrier and jacket	800 – 1500 mm 100-800 mm
3	SAFCO-2 Expansion	TECHNIMONT	Consolidate Contracting Co. (C.C.C)	Butt Wrap Site Connections	25 – 3500 mm
4	Jubail Petrochemical Complex	SABIC	Saudi Bin Laden Group (PCM)	FRP pipe system site connection	50 – 2300 mm
5	Petro Kemya Polyethylene Project	Petrokemya	Gamma Al-Moushegay Arabia Ltd.	Butt Wrap site connections for pipe and fittings	200 – 1500 mm

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
6	Replacement of Chlorination Plant, Piping of phase I and Installation of Gas separators	Saudi Electricity Co. (SCECO Eastern)	SCECO Eastern Province	Supply & Erection of FRP pipes / spools, site connections, Supervision and Inspection	25 – 300 mm
7	Al-Sharq	SABIC	Consolidate Contracting Co. (C.C.C)	Butt Wrap Site Connections	1000 – 2000 mm
8	Shoaiba Power Plant phase 2, Lot 1 A	SWCC	Saudi Arabian Bechtel Co.	Adhesive and Butt Wrap site connections for pipes and fittings	80 – 900 mm
9	Haradh Gas Project	Saudi Aramco	Technip (Italy)	Butt Wrap site connections for pipe and fittings	1600 mm
10	King Abdul Aziz Air Base, Dhahran	United States Department of Defense	Al-Sari Contracting Co.	Supply of Erection of FRP pipes / spools, site, connection, supervision and Inspection	200 – 600 mm

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
11	Ibn Zahr Expansion	SABIC	Saudi Bin Laden Group	Adhesive and Butt Wrap site connections for pipes and fittings.	25 – 350 mm
12	Kemya Major Expansion (ISBL)	SABIC	Bekllast Nedam Group. N.V	Adhesive and Butt Wrap site connections for pipes and fittings.	25 – 2000 mm
13	PetroKemya Expansion	SABIC	Dywidag (Germany)	Adhesive and Butt Wrap site connections for pipes and fittings.	25 – 2000 mm
14	Al-Khobar 2 and PS A1 Aziziyah	SWCC	TEKFEN Insaat VE Tessisat A.S.	Engineering, Supply & Erection of FRP pipes / spools, Tanks, site connection, supervision and inspection	25 – 200 mm
15	Amiantit Group of Companies, Dammam – K.S.A	Amiantit		FRP lining of Steel Tank (6m dia. Height = 8 meters)	

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
16	SOHAR REFINERY	Oman Petroleum	Consolidate Contracting Co. (C.C.C)	Butt Wrap site connection	450 – 2000 mm
17	SAFCO – IV Expansion	SABIC	Raymonds Saudi Arabia	Butt Wrap site connection	450 – 2000 mm
18	Royal Commission East Pumping Station Expansion	Royal Commission Jubail	Al-Ertifaa	Supply, Fabrication & Installation of Pipes/Fittings	1400 mm
19	SWCC – Jubail Plant 74.6 MIGD PWTEP	SWCC – Jubail	Pipe Technology System	Supply of FRP pipes & fittings. Install of pipes / fittings	1500 – 2100 mm
20	DHT Complex Project Yanbu Refinery	Saudi Aramco	TEKFEN TRGS	Erection of RTR pipes & fittings FRP Coupling Joints	25 – 400 mm 25 – 900 mm

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
21	Preparation of Manifa Area	Saudi Aramco	AbdulRahman Al-Shalawi Co.	3250 L.M/RTR underground pipeline with civil work – Adhesive Joints	400 mm
22	Preparation of Manifa Area	Saudi Aramco	AbdulRahman Al-Shalawi Co.	Wrapping Joints between FRP Manholes & UPVC pipes	110 – 630 mm
23	Wessa Water Station – Abo Gonima (Hofuf)	Ministry of Water & Electricity	Civil Works Co. (CWC)	RTR underground pipelines / fittings with Adhesive Joints FRP underground lines/fittings with butt & wrap joints	900 mm for RTR 1400 mm for FRP
24	Bawarge One Sweet Water Plant	Saudi Berkefeld Filters Co. Ltd (WETICO)	Saudi Berkefeld Filters Co. Ltd (WETICO)	Butt & wrap joints for FRP pipelines and fittings and installation of complete fiberglass piping system (B&W).	100 – 500 mm
25	Bawarge Two	Saudi Berkefeld Filters Co. Ltd (WETICO)	Saudi Berkefeld Filters Co. Ltd (WETICO)	Butt & wrap joints for FRP pipelines & fittings	100 – 500 mm

SL.#	PROJECT NAME	CLIENT	CONTRACTOR	TYPE OF WORK	DIAMETER RANGE
26	S-Chem Saudi Chevron	S-Chem	S-Chem	Emergency Maintenance Works & Fabrication (3 Jobs completed)	100 – 250 mm
27	S.W.C.C – Al Khafji	S.W.C.C	S.W.C.C	Emergency repair (Fabrication & Laminations / Butt & wrap joints) for FRP pipes & air tanks	50 – 300 mm
28	Six Filter skids for sweet water stations	Saudi Aramco - Sheba	Saudi Berkefeld Filters Co. Ltd. (WETICO)	Installing & jointing more than 700 adhesive joints for RTR lines	25 – 250 mm
29	Prince Sultan Air Base (Al Kharj)	Minister of Defense & Air force	Arab Establishment Projects Co. (AEP)	Testing for existing RTR lines (Hydro Test) – Supply pipes & fittings for repairing works – more than 100 Butt & Wrap RTR Joints Done	50 – 500 mm
30	Repairing for FRP Pipes – Madina Al Munawwar	Saudi Tumpane Co.	Saudi Tumpane Co.	Repairing of damaged FRP pipes underground (Butt & Wrap)	1800 mm

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31	Al Bairony	SABIC	Olayan Descon Co.	Installing & Jointing for two FRP lines (Butt & Wrap Joints) Installing & Jointing for two RTR lines (Adhesive Joints)	300 mm for FRP 50 – 300 mm for RTR
32	Fabrication / Installing & Jointing for FRP	Kingdom Oasis Showrooms - Ar Riyadh	Saudi Berkefeld Filters Co. Ltd. (WETICO)	Fabrication / Installing & Jointing for FRP Ducts & Pipes	100 – 500 mm
33	Repairing Works for RTR pipes / Joints	Saudi Aramco	Nesma & Partners Co.	Repairing for underground RTR pipelines (Adhesive Joints)	160 – 1200 mm
34	S.W.C.C	S.W.C.C	S.W.C.C – Jubail	Supplying Fabrication FRP Spools	100 mm